CHAPTER 80

LIST OF EFFECTIVE TEMPORARY REVISIONS

FOLLOWING IS A COMPLETE LISTING OF ALL ACTIVE TEMPORARY REVISIONS (TR'S). TR'S NOT LISTED SHOULD BE REMOVED. THE ATA NUMBER, CONFIG CODE AND PAGE NUMBER IDENTIFIES THE PAGE PRECEDING THE TR.

TR NUMBER	ATA NUMBER	CONFIG CODE	PAGE NUMBER	TR DATE

NONE

CHAPTER/ SECTION	PAGE	DATE	CONFIG CODE	CHAPTER/ SECTION	PAGE	DATE	CONFIG CODE
80-11-02	401	Aug 15/81					
80-11-02	402	Aug 15/81					
80-11-07	301	Nov 15/81					
80-11-07	302	Nov 15/89					
80-11-07	303/304	Nov 15/89					
80-11-07	401	Mar 15/84					
80-11-07	402	Mar 15/84					
80-11-07	403	Mar 15/81					
80-11-07	404	Jul 15/84					
80-11-07	501	May 15/87					
80-11-07	502	May 15/77					
80-11-07	503/504	May 15/87					
80-11-07	601	May 15/82					
80-11-07	602	Jul 15/84					
80-11-07	603	May 15/77					
80-11-07	604	Jul 15/84					
80-11-07	605	May 15/85					
80-11-07	606	Jul 15/84					
80-11-08	201	May 15/90					
80-11-08	202	May 15/90					
80-11-08	203	Jun 15/94					
80-11-08	204	Jun 15/94					
80-11-08	401	Nov 15/81					
80-11-08	402	Nov 15/81					
80-11-08	403	Jun 15/94					
80-11-08	404	Jun 15/94					
80-11-08	601	Feb 15/82					
80-11-08	602	Feb 15/82					
80-11-08	603	Jun 15/94					
80-11-08	604	Jun 15/94					
80-11-15	401	May 15/77					
80-11-15	402	May 15/77					
80-11-17	401	May 15/77					
80-11-17	402	May 15/77					
80-11-18	401	Aug 15/81					
80-11-18	402	Jun 15/94					
80-11-18	403	Jun 15/94					
80-11-18	404	Jun 15/94					
80-11-19	401	Aug 15/81					
80-11-19	402	Jun 15/94					
80-11-19	403	Jun 15/94					
80-11-19	404	Jun 15/94					
80-11-19	701/702	Aug 15/81					

CHAPTER 80

STARTING

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Description and Operation		1	ALL
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CHAPTER 80-STARTING

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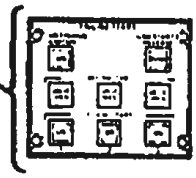
TAKE-OFF SURGE	7100
TGT INDICATOR	7721
THROTTLE STAGGER	7100

POWER PLANT CONTENTS

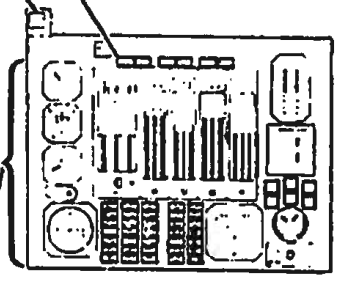
- GROUND START VALVE OPEN LIGHT
- STARTING
- FAILURE TO RELIGHT/REACH IDLE--WINDMILLING
- FAILURE TO RELIGHT/REACH IDLE–STARTER ASSIST



(CENTER CONSOLE)

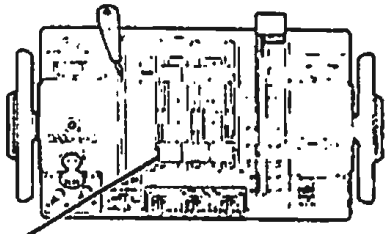
- REVERSE THRUST
- REVERSE THRUST SELECTED
- REVERSE THRUST CANCELLED
- IN FLIGHT

- ENG 2 FAIL LIGHT
- STARTING
- POSSIBLE OVERTEMPERATURE/HIGH TEMPERATURE
- DECREASE/FLUCTUATION OF POWER
- ENGINE FLAMEOUT
- TAKE-OFF SURGE
- IN-FLIGHT SURGE
- FAILURE TO RELIGHT/REACH IDLE–WINDMILLING
- FAILURE TO RELIGHT/REACH IDLE–STARTER ASSIST
- EPR INDICATOR
- FF/FUEL USED INDICATOR
- N1 INDICATOR
- N3 INDICATOR
- TGT INDICATOR
- OVERTEMPERATURE (EXCEPT STARTING)
- OVERTEMPERATURE (STARTING AND RELIGHTING)



(CENTER INSTRUMENT PANEL)

- DECREASE/FLUCTUATION OF POWER
- THROTTLE STAGGER



(PILOTS OVERHEAD PANEL)

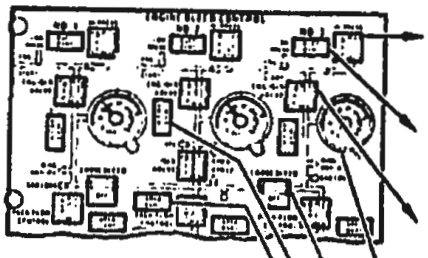
M1–0001–71–8504

R STARTING CONTENTS

R EFFECTIVITY: ALL

R
001B

POWERPLANT CONTENTS



(FE/SO PANEL)

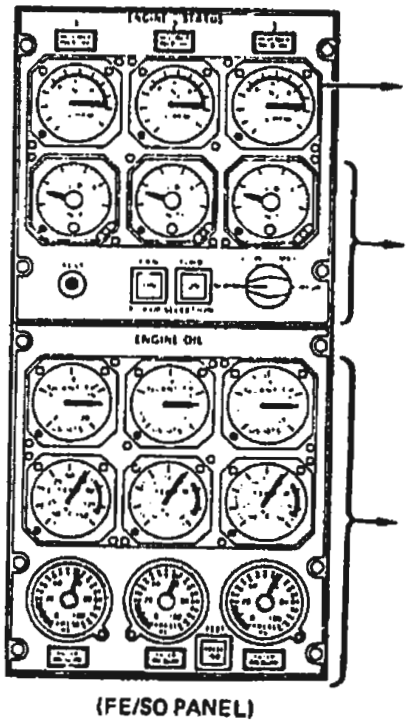
CROSSBLEED START
ENGINE BLEED AIR
NACELLE/PYLON
OVERHEAT DETECTION

DUCT OVHT, ENGINE
(1, 2, OR 3)

GROUND START VALVE
OPEN LIGHT
ENGINE BLEED AIR

CROSSBLEED START
POSSIBLE
OVERTEMPERATURE/HIGH
TEMPERATURE
ENGINE BLEED AIR

CROSSBLEED START
AREA OVHT, BLEED AIR
(J)
AREA OVERHEAT TEST
AREA OVHT, BLEED AIR
(D, E, OR H)



(FE/SO PANEL)

STARTING

AIRBORNE VIBRATION
MONITOR
N2 OVERSPEED
N2 INDICATOR

ABNORMAL OIL SYSTEM
INDICATIONS
RISE IN FUEL/OIL
TEMPERATURE
STARTING
OIL PRESSURE LOW/HIGH
OIL FILTER PRESSURE
LIGHT
ENGINE FLAMEOUT

TITLE	CHAP/SEC
ABNORMAL OIL SYSTEM INDICATIONS	7900
AIRBORNE VIBRATION MONITOR	7731
AREA OVERHEAT TEST	3600
AREA OVHT, BLEED AIR (D, E, OR H)	3600
AREA OVHT, BLEED AIR (J)	3600
CROSSBLEED START	3600
DUCT OVHT, ENGINE (1, 2, OR 3)	3600
ENGINE BLEED AIR	3600
ENGINE FLAMEOUT	7100
GROUND START VALVE OPEN LIGHT	8011
NACELLE/PYLON OVERHEAT DETECTION	2600
N2 INDICATOR	7712
N2 OVERSPEED	7100
OIL FILTER PRESSURE LIGHT	7900
OIL PRESSURE LOW/HIGH	7900
POSSIBLE OVERTEMPERATURE/ HIGH TEMPERATURE	7100
RISE IN FUEL/OIL TEMPERATURE	7337
STARTING	7100

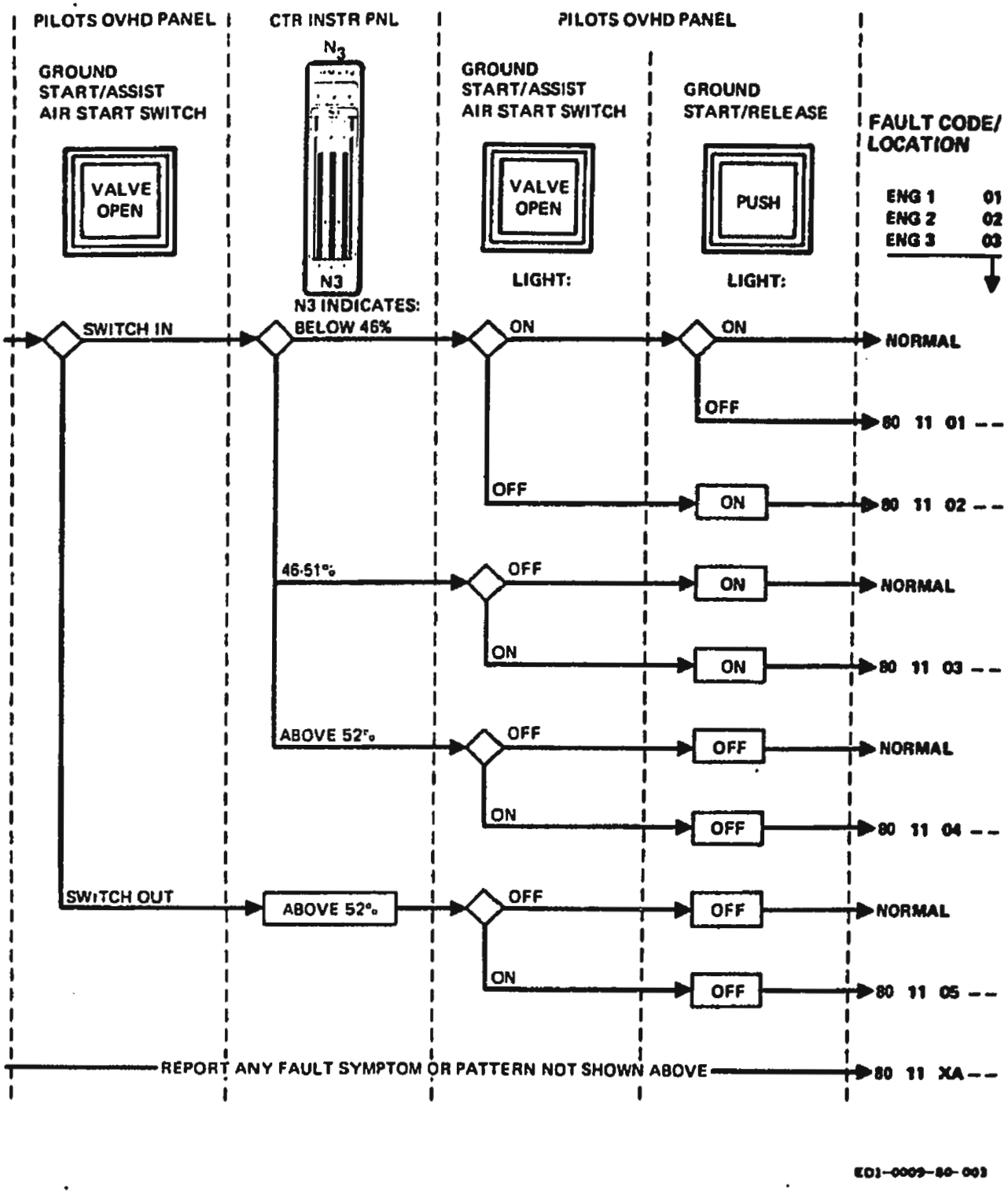
M1-0002-71-8505

R

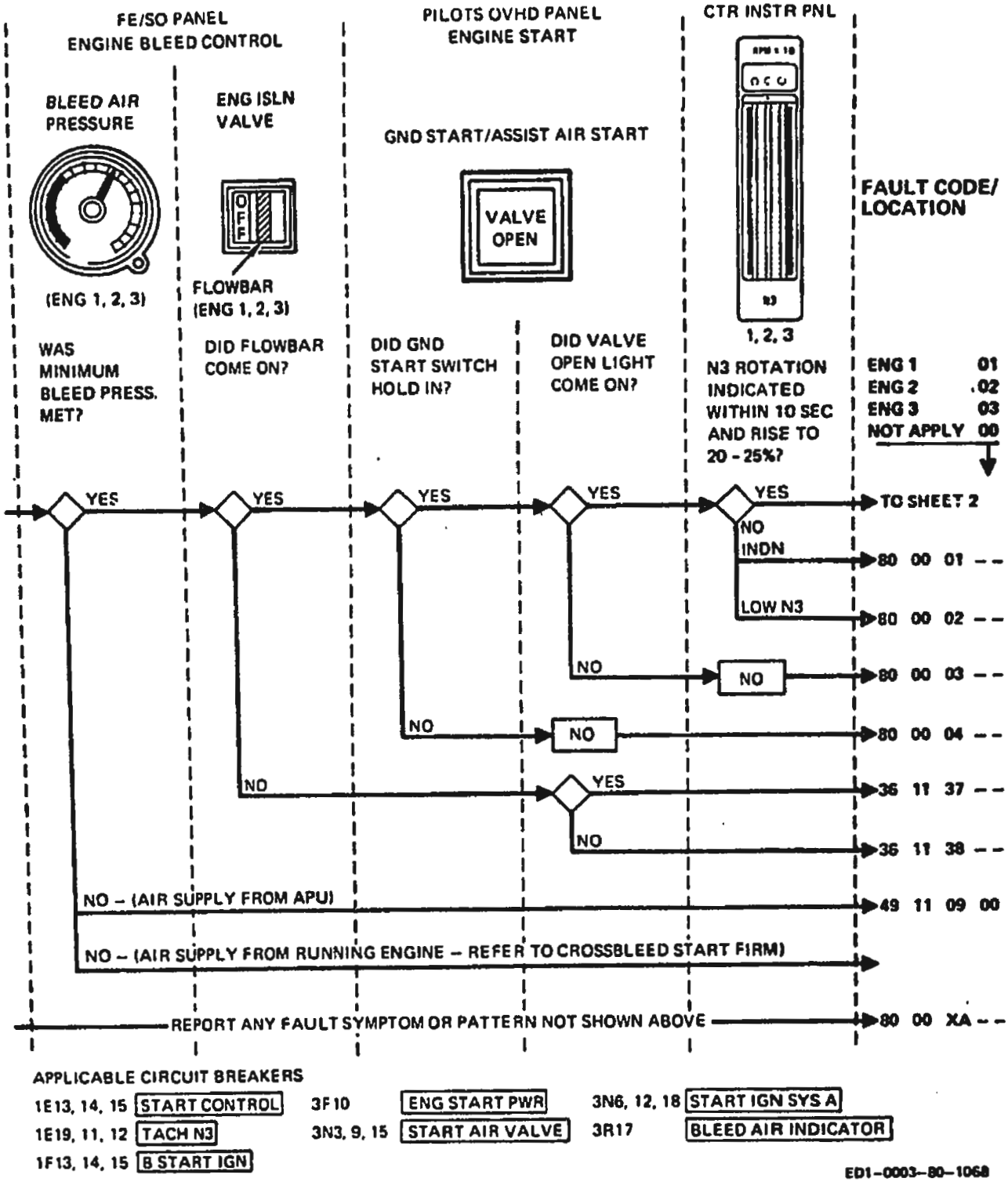
STARTING CONTENTS

EFFECTIVITY: ALL

001B



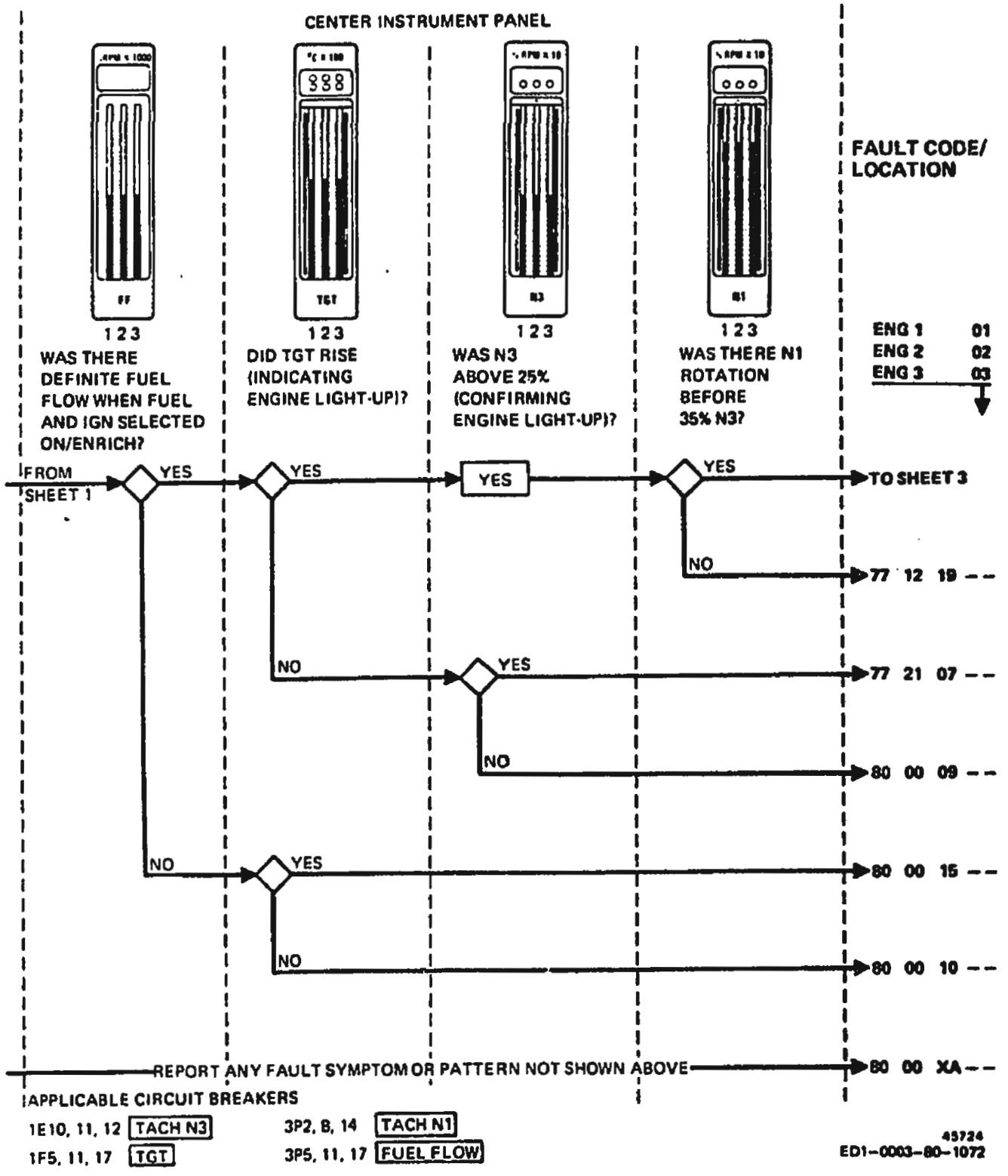
R Ground Start VALVE OPEN Light - Fault Codes
Figure 1


FE/SO PANEL
ENGINE BLEED CONTROL
PILOTS OVHD PANEL
ENGINE START
CTR INSTR PNL
BLEED AIR PRESSURE
ENG ISLN VALVE
GND START/ASSIST AIR START
FAULT CODE/ LOCATION
OFF
VALVE OPEN
(ENG 1, 2, 3)
FLOWBAR (ENG 1, 2, 3)
1, 2, 3
WAS MINIMUM BLEED PRESS. MET?
DID FLOWBAR COME ON?
DID GND START SWITCH HOLD IN?
DID VALVE OPEN LIGHT COME ON?
N3 ROTATION INDICATED WITHIN 10 SEC AND RISE TO 20 - 25%?
ENG 1 01
ENG 2 02
ENG 3 03
NOT APPLY 00
YES
NO
INDN
LOW N3
TO SHEET 2
80 00 01 - -
80 00 02 - -
80 00 03 - -
80 00 04 - -
36 11 37 - -
36 11 38 - -
NO - (AIR SUPPLY FROM APU)
49 11 09 00
NO - (AIR SUPPLY FROM RUNNING ENGINE - REFER TO CROSSBLEED START FIRM)
REPORT ANY FAULT SYMPTOM OR PATTERN NOT SHOWN ABOVE
80 00 XA - -
APPLICABLE CIRCUIT BREAKERS
1E13, 14, 15 START CONTROL
1E19, 11, 12 TACH N3
1F13, 14, 15 B START IGN
3F10 ENG START PWR
3N3, 9, 15 START AIR VALVE
3N6, 12, 18 START IGN SYS A
3R17 BLEED AIR INDICATOR
ED1-0003-80-1068

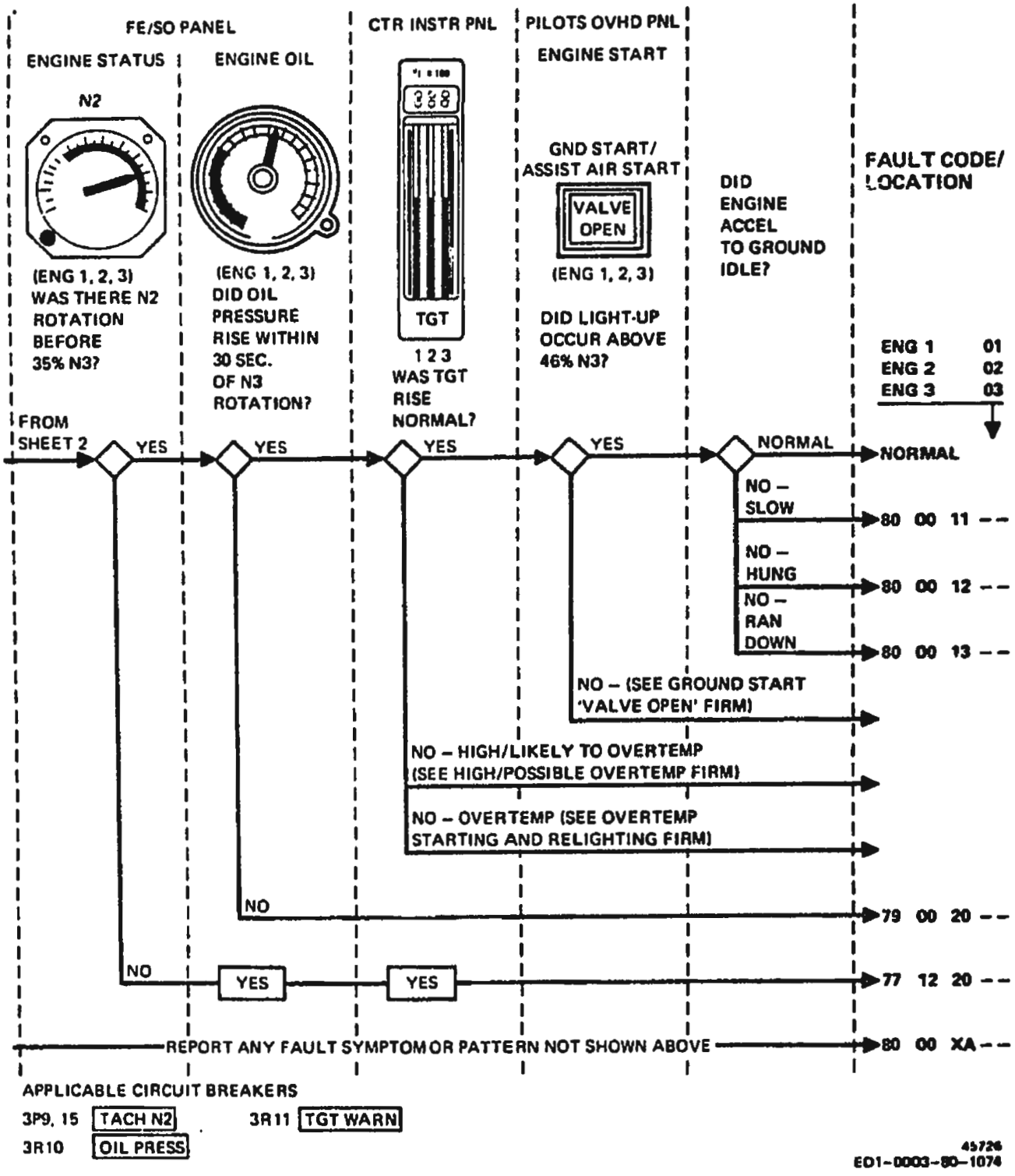
R

Starting (Sheet 1) - Fault Codes
Figure 2

EFFECTIVITY: ALL


CENTER INSTRUMENT PANEL
FAULT CODE/ LOCATION
1 2 3
WAS THERE DEFINITE FUEL FLOW WHEN FUEL AND IGN SELECTED ON/ENRICH?
1 2 3
DID TGT RISE (INDICATING ENGINE LIGHT-UP)?
1 2 3
WAS N3 ABOVE 25% (CONFIRMING ENGINE LIGHT-UP)?
1 2 3
WAS THERE N1 ROTATION BEFORE 35% N3?
ENG 1 01
ENG 2 02
ENG 3 03
FROM SHEET 1
YES
NO
TO SHEET 3
77 12 19 - -
77 21 07 - -
80 00 09 - -
80 00 15 - -
80 00 10 - -
REPORT ANY FAULT SYMPTOM OR PATTERN NOT SHOWN ABOVE
80 00 XA - -
APPLICABLE CIRCUIT BREAKERS
1E10, 11, 12 TACH N3
1F5, 11, 17 TGT
3P2, 8, 14 TACH N1
3P5, 11, 17 FUEL FLOW
45724
ED1-0003-80-1072

R Starting (Sheet 2) - Fault Codes
Figure 3



R Starting (Sheet 3) - Fault Codes
Figure 4

EFFECTIVITY: ALL

80-FAULT CODE DIAGRAM

FAULT CODE INDEX
TABLE 1

FAULT CODE	1. LOG BOOK REPORT 2. FAULT ISOLATION REFERENCE
80 00 XA __	1. A Starting fault was encountered by the crew which is not covered in the fault code diagram. (Ref. Fault Code diagram for flight crew actions.)
	2. 80-00-00 Fig. 103, 104, 105, 106, 107, 108 Block
80 11 XA __	1. A Ground Start VALVE OPEN Light fault was encountered by the crew which is not covered in the fault code diagram. (Ref. Fault Code diagram for flight crew actions.)
	2. 80-11-00 Fig. 103 Block 1
80 00 00 00	1. NOT USED.
80 00 01 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) no indication of N3 rotation when start initiated. Bleed air pressure sufficient and VALVE OPEN light on.
	2. 80-00-00 Fig. 103 Block 7
80 00 02 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) motoring speed was low (low N3). Bleed air pressure sufficient and VALVE OPEN light on.
	2. 80-00-00 Fig. 106 Block 1
80 00 03 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) VALVE OPEN light did not come on during start. No indication of engine rotation.
	2. 80-00-00 Fig. 104 Block 1
80 00 04 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) GROUND START switchlight did not hold in during start. No indication of engine rotation.
R	2. 80-00-00 Fig. 103 Block 2
80 00 05 00	1. NOT USED.
80 00 06 00	1. NOT USED.

FAULT CODE INDEX
TABLE 1 (CONTINUED)

FAULT CODE	1. LOG BOOK REPORT 2. FAULT ISOLATION REFERENCE
80 00 07 00	1. NOT USED.
80 00 08 00	1. NOT USED.
80 00 09 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) did not light-up. There was definite indication of fuel flow. 2. 80-00-00 Fig. 105 Block 9
80 00 10 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) did not light-up. No indication of fuel flow. 2. 80-00-00 Fig. 105 Block 2
80 00 11 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) slow to accelerate to ground idle. 2. 80-00-00 Fig. 107 Block 3
80 00 12 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) hung start. 2. 80-00-00 Fig. 107 Block 3
80 00 13 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) ran down after light-up. 2. 80-00-00 Fig. 107 Block 3
R 80 00 14 __	1. (01=Eng 1, 02=Eng 2, 03=Eng 3) lights-up but maximum T.G.T. appears likely to be exceeded. Motoring speed (approximately 25% N3) was not achieved. Start was aborted at ___ degrees C. 2. 80-00-00 Fig. 106 Block 1
80 00 15 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) engine light-up but no definite indication of fuel flow. 2. 80-00-00 Fig. 105 Block 2

FAULT CODE INDEX
TABLE 1 (CONTINUED)

FAULT CODE	1. LOG BOOK REPORT 2. FAULT ISOLATION REFERENCE
R 80 00 16 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) lights-up but maximum T.G.T. appears likely to be exceeded. Motoring speed (approximately 25% N3) was not achieved. Start was aborted at ___ degrees C. Starter operated continuously for five minutes or more.
R	2. 80-00-00 Fig. 106 Block 1
80 11 01 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) GND START RELEASE PUSH light off during start with N3 below 46%. All other start indications normal.
	2. 80-11-00 Fig. 103 Block 8
80 11 02 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) GND START/ASSIST AIR START VALVE OPEN light off during start with N3 below 46%. All other start indications normal.
	2. 80-11-00 Fig. 103 Block 3
80 11 03 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) GND START/ASSIST AIR START VALVE OPEN light on during start with N3 between 46% and 51%. ENG ISLN VALVE flow bar on and GND START RELEASE PUSH light on.
	2. 80-11-00 Fig. 103 Block 3
80 11 04 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) GND START/ASSIST AIR START VALVE OPEN light on during start with N3 above 52%. All other lights off and indications normal.
	2. 80-11-00 Fig. 103 Block 6 80-11-00 Fig. 103 Block 8
80 11 05 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) GND START/ASSIST AIR START VALVE OPEN light on after 52% N3 and switch out. All other start indications normal.
	2. 80-11-00 Fig. 103 Block 4

FAULT CODE INDEX
TABLE 1

FAULT CODE	1. LOG BOOK REPORT 2. FAULT ISOLATION REFERENCE
R 80 11 06 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) lights up but maximum TGT appears likely to be exceeded. Rapid increase in TGT occurred at or below 32% N3. Starting fuel flow normal. Start aborted at ___ degrees C. Starter operated continuously for five minutes or more.
R	2. 80-11-00 Fig. 103 Block 1 71-88-00 Fig. 103 Block 3
R 80 11 07 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) lights up but maximum TGT appears likely to be exceeded. Rapid increase in TGT occurred above 32% N3. Starting fuel flow normal, GND START switch did not release before 51% N3. Start aborted at ___ degrees C. Starter operated continuously for five minutes or more.
R	2. 80-11-00 Fig. 103 Block 1 71-88-00 Fig. 104 Block 5
R 80 11 08 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) lights up but maximum TGT appears likely to be exceeded. Rapid increase in TGT occurred above 32% N3. VALVE OPEN light went out before 43% N3. Start aborted at___ degrees C. Starter operated continuously for five minutes or more. (Ref. Chapter 71 for Fault Code diagram.)
R	2. 80-11-00 Fig. 103 Block 1 71-88-00 Fig. 104 Block 2
R 80 11 09 __	1. (01=ENG 1, 02=ENG 2, 03=ENG 3) lights up but maximum TGT appears likely to be exceeded. Rapid increase in TGT occurred above 32% N3. GND START switch released before 51% N3. Start aborted at ___ degrees C. Starter operated continuously for five minutes or more.
R	2. 80-11-00 Fig. 103 Block 1 71-88-00 Fig. 104 Block 4

STARTING
DESCRIPTION AND OPERATION

1. General

Engine starting is accomplished through the integrated functions of the following systems:

Engine Starting System	Ref. 80-11-00
Engine Fuel and Control System	Ref. 73-00-00
Ignition System	Ref. 74-00-00
Pneumatic System	Ref. 36-00-00

Pressurized air passing through the pneumatic system ducts operates air turbine starter motors which provide the energy for cranking the three turbofan engines. As each engine accelerates, the high-pressure compressor, aided by the intermediate-pressure compressor, delivers pressurized air to the engine combustion section where fuel is introduced through operation of the engine fuel control system. The ignition system provides the spark for fuel ignition when the correct fuel/air ratio exists in the annular combustion chamber.

Some engine starting functions, such as power lever positioning, are directly related to engine controls (Ref. 76-00-00). Automatic termination of starter cranking, following ignition, is a function of engine indicating (Ref. 77-00-00) through action of switches in the corresponding N3 shaft speed indicators. The auxiliary power unit (APU) (Ref. 49-00-00) is the primary source of pneumatic power for engine cranking.

STARTING - FAULT ISOLATION

1. General

The diagrams and schematics in this section can be used for fault isolation any time a fault is reported or suspected. Uncommon abbreviations are defined on the using fault code diagram or schematic.

If the flight crew reports a fault using a fault code number, the code number can be found in the Fault Isolation Reference Table in the Chapter 71 Fault Code Index. The index specifies the exact maintenance manual section, fault isolation diagram, and block number on the diagram where the fault isolation procedure should start. Where applicable, schematics are included at the end of the section to supplement the fault code diagrams or as an aid in isolating a problem not covered on the diagrams.

Refer to the Maintenance Manual Introduction for a more detailed discussion of the Fault Isolation Reporting Method (FIRM) and use of fault isolation diagrams/schematics.

CR When starting RB211 engines, be alert to N3 indication
CR malfunctions, hung starts, engine spool down and adhere to the
CR following procedure:

CR To minimize the possibility of starter re-engagement during an
CR abandoned start above 35 per cent N3, the ground start release
CR switch must be pushed immediately after selecting fuel and
CR ignition off provided EGT is below 550 degrees. If required in
CR an emergency, the starter may be re-engaged at N3 of 20 percent
CR or less. However, to reduce possibility of gear box gearshaft
CR failure, it is recommended, where operationally practical, that
CR N3 be allowed to run down to zero before starter is engaged.

CR In the event a crach re-engagement is reported or suspected, a
CR check of the high speed gear box magnetic chip detector is
CR required.

2. Fault Isolation/Identification

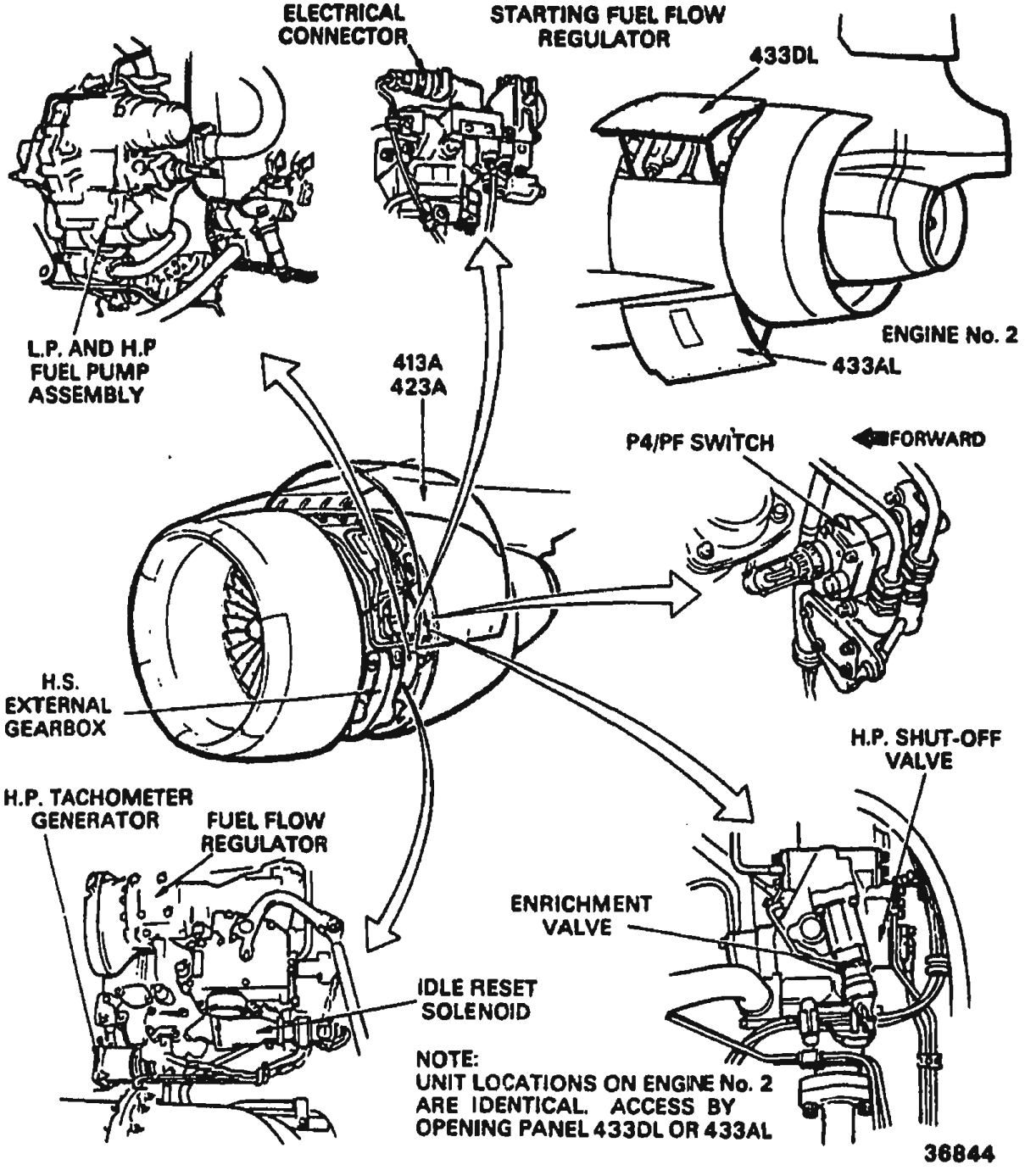
Table 101 lists the fault isolation diagrams and schematics in this section.

TABLE 101

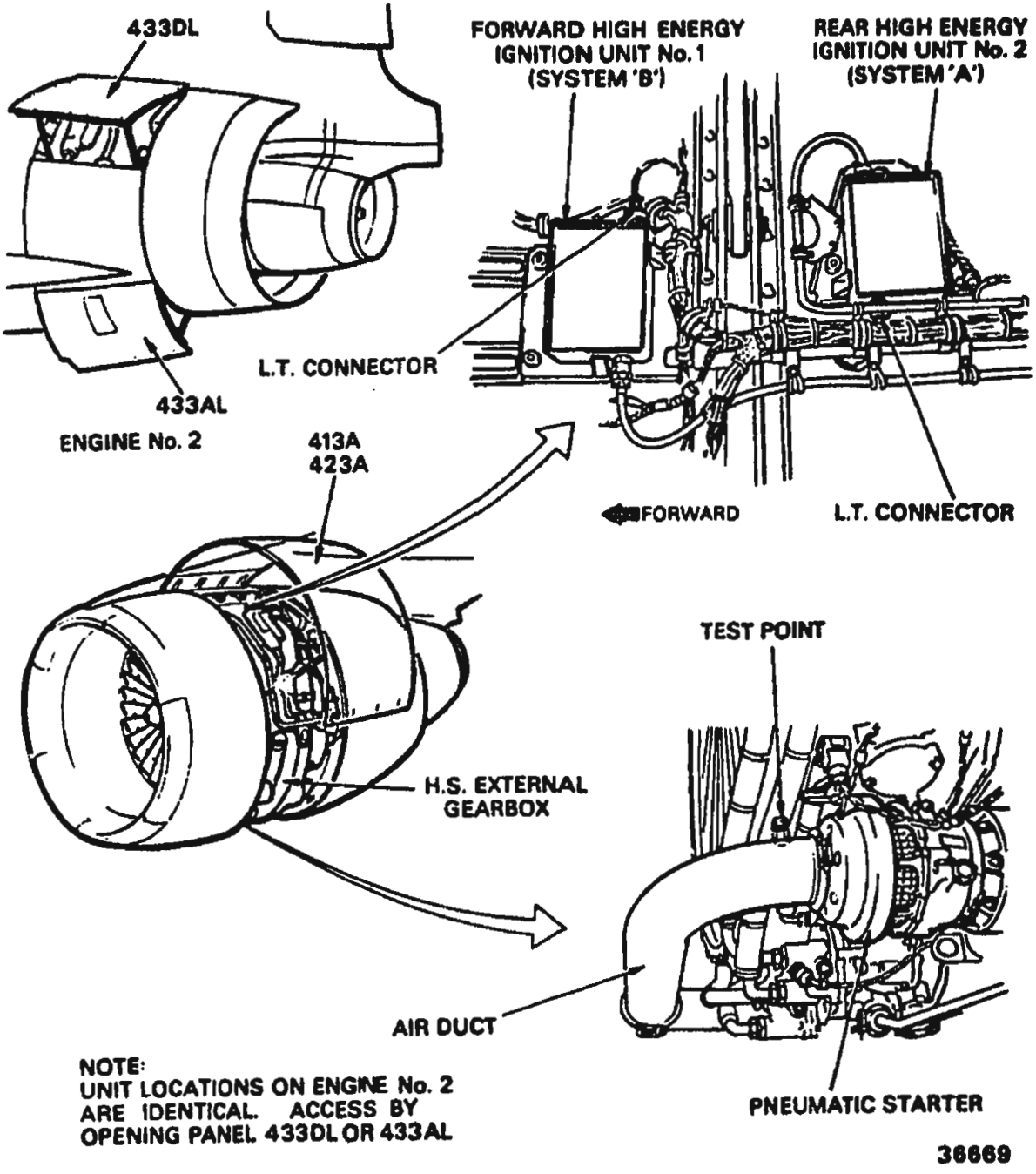
FIGURE	TITLE
Fig.103	Engine does not rotate when start initiated
Fig.104	'Valve open' light out. No indication of N3 rotation when start initiated
Fig.105	Engine rotates but does not light-up
Fig.106	Unable to achieve motoring speed (25% N3 approximately)
Fig.107	Hung start/Engine slow to accelerate to ground idle
Fig.108	Failure to relight until altitude reduced

	COMPONENT	QTY	ACCESS/AREA	REFERENCE
	BOX - IGNITER	6	ENGINE: 413A, 423A, 433DL	74-11-01
	GEARBOX - HIGH SPEED EXTERNAL (MODULE 06)	3	ENGINE: 413A, 423A, 433AL	72-00-06
	INDICATOR - N3	3	PILOT MAIN INST: 210	77-12-07/08
	LEAD - IGNITER	6	ENGINE: 411, 421, 431	74-21-01
	PLUG - IGNITER	6		74-21-02
	PUMP - FUEL, HP AND LP	3	ENGINE: 413A, 423A, 433AL	73-11-01
	REGULATOR - FUEL FLOW	3	ENGINE: 413A, 423A, 433AL	73-21-01
	REGULATOR - STARTING FUEL FLOW	3	ENGINE: 413A, 423A, 433DL	73-21-03
R	RELAY - FUEL SHUT-OFF	3	MESC: 192K	20-24-01
R	RELAY - GROUND START	3	MESC: 192K	20-24-01
R	RELAY - IGNITION LOCKOUT	3	MESC: 192K	20-24-01
R	RELAY - N3 TACHO - 51%	3	MESC: 192K	20-24-01
	SOLENOID - STARTER CONTROL VALVE	3	ENGINE: 413A, 423A, 433AL	80-11-18
	STARTER - AIR	3	ENGINE: 413A, 423A, 433AL	80-11-07
	SWITCH - FUEL AND IGNITION	3	PILOTS CENTRE CONSUL: 210	74-11-01/02/03
	SWITCH - P4/PF	3	ENGINE: 413A, 423A, 433DL	73-21-13
	UNIT - STARTING CONTROL	3	ENGINE: 413A, 423A, 433DL	73-21-25
	VALVE - ENGINE	3		36-11-18/19
R	ISOLATION			
	VALVE - HP FUEL	3	ENGINE: 413A, 423A, 433AL	73-11-04
R	SHUT-OFF			
	VALVE - STARTER CONTROL	3	ENGINE: 413A, 423A, 433AL	80-11-08

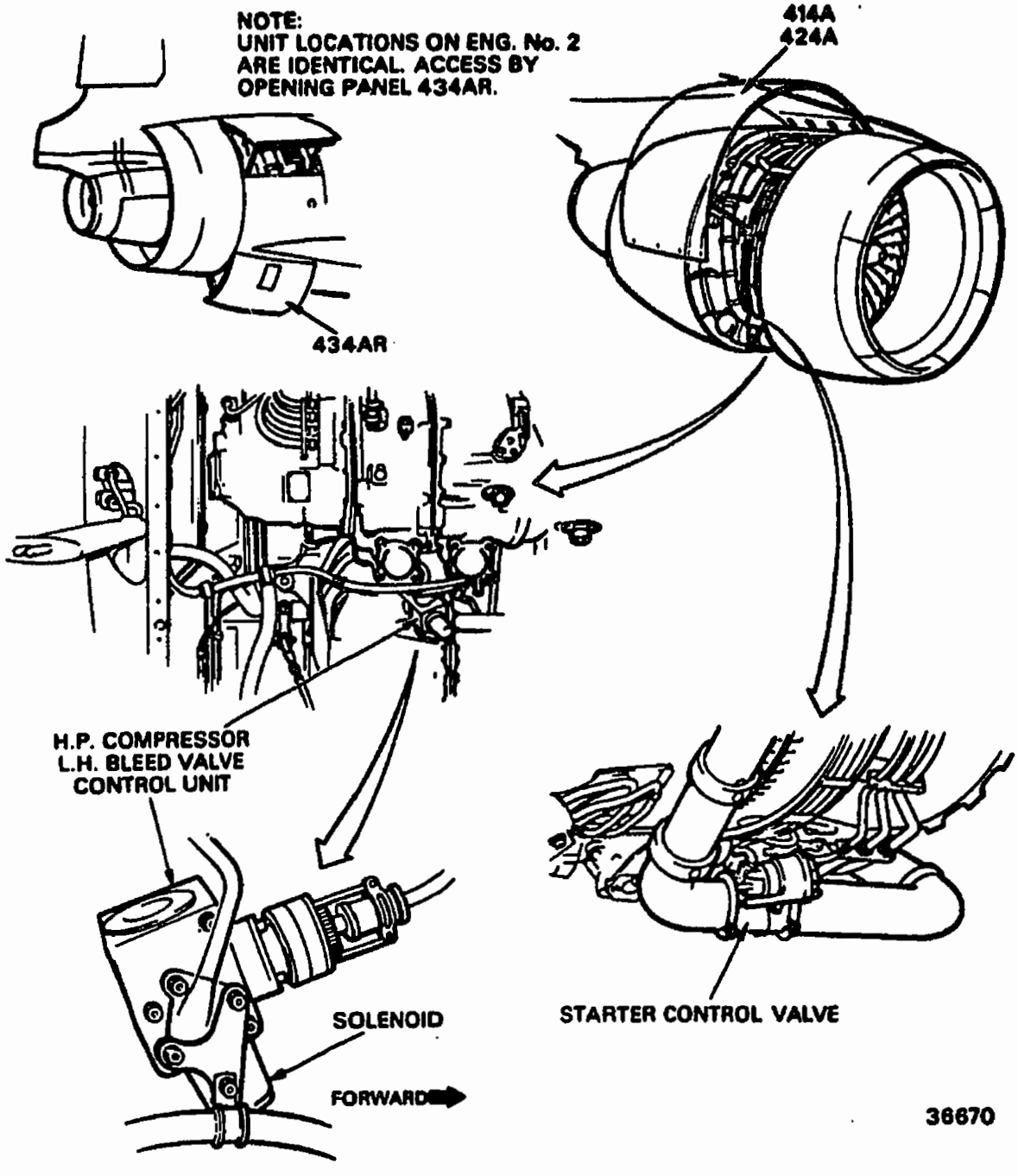
Component Location Index
Fig.101



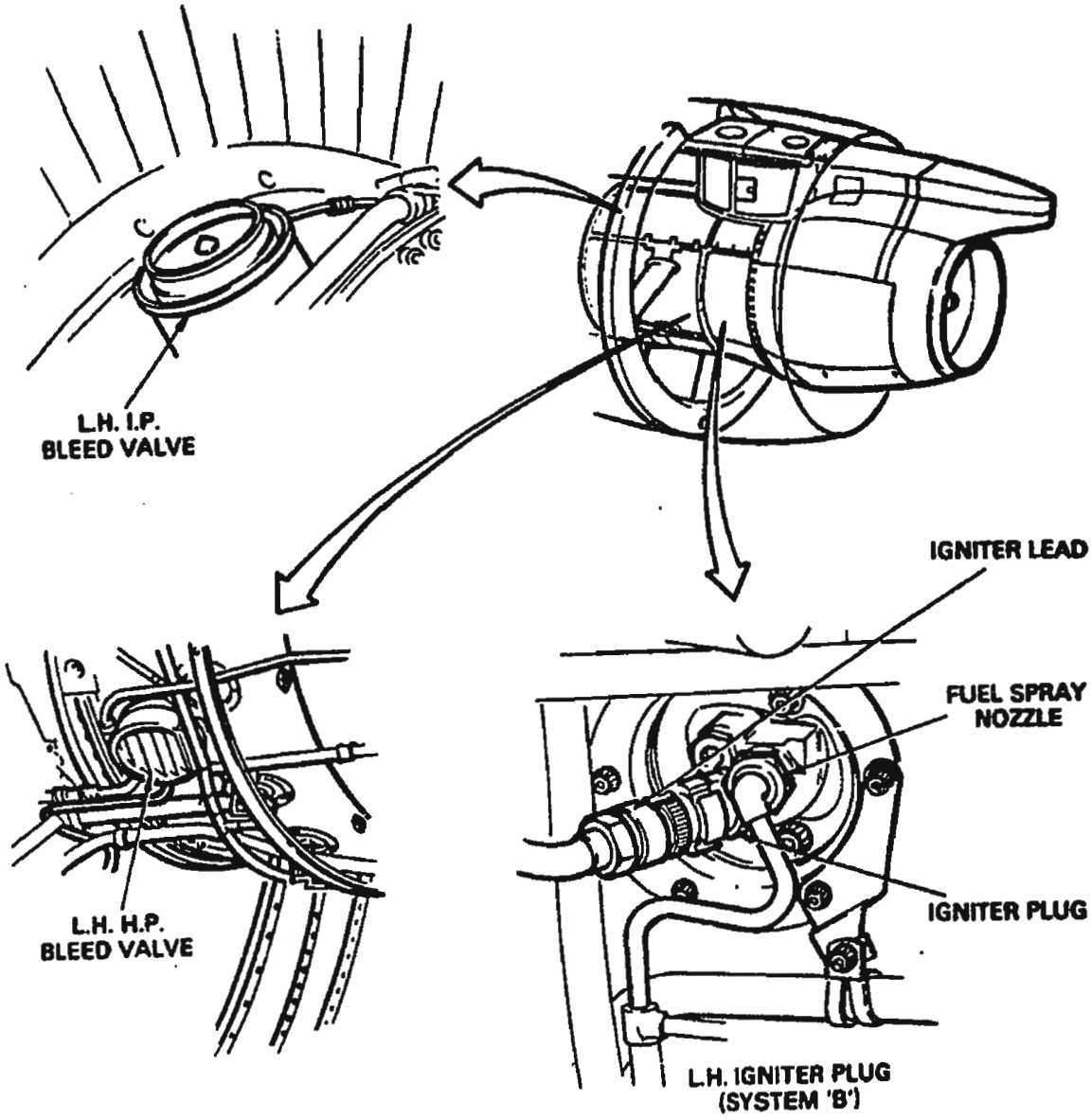
Component Locator Diagram
Fig.102 (Sheet 1 of 6)



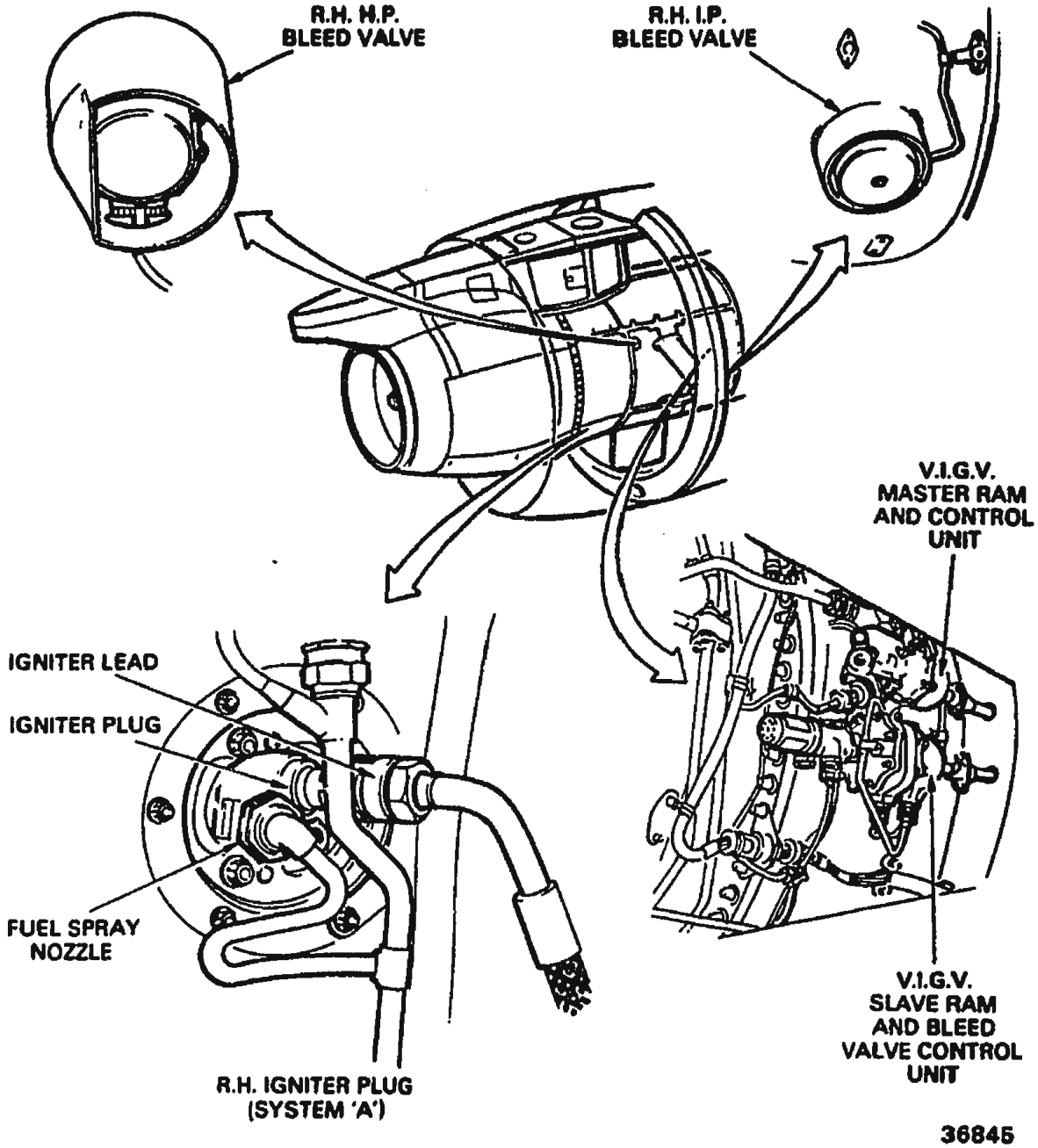
Component Locator Diagram
Fig.102 (Sheet 2 of 6)



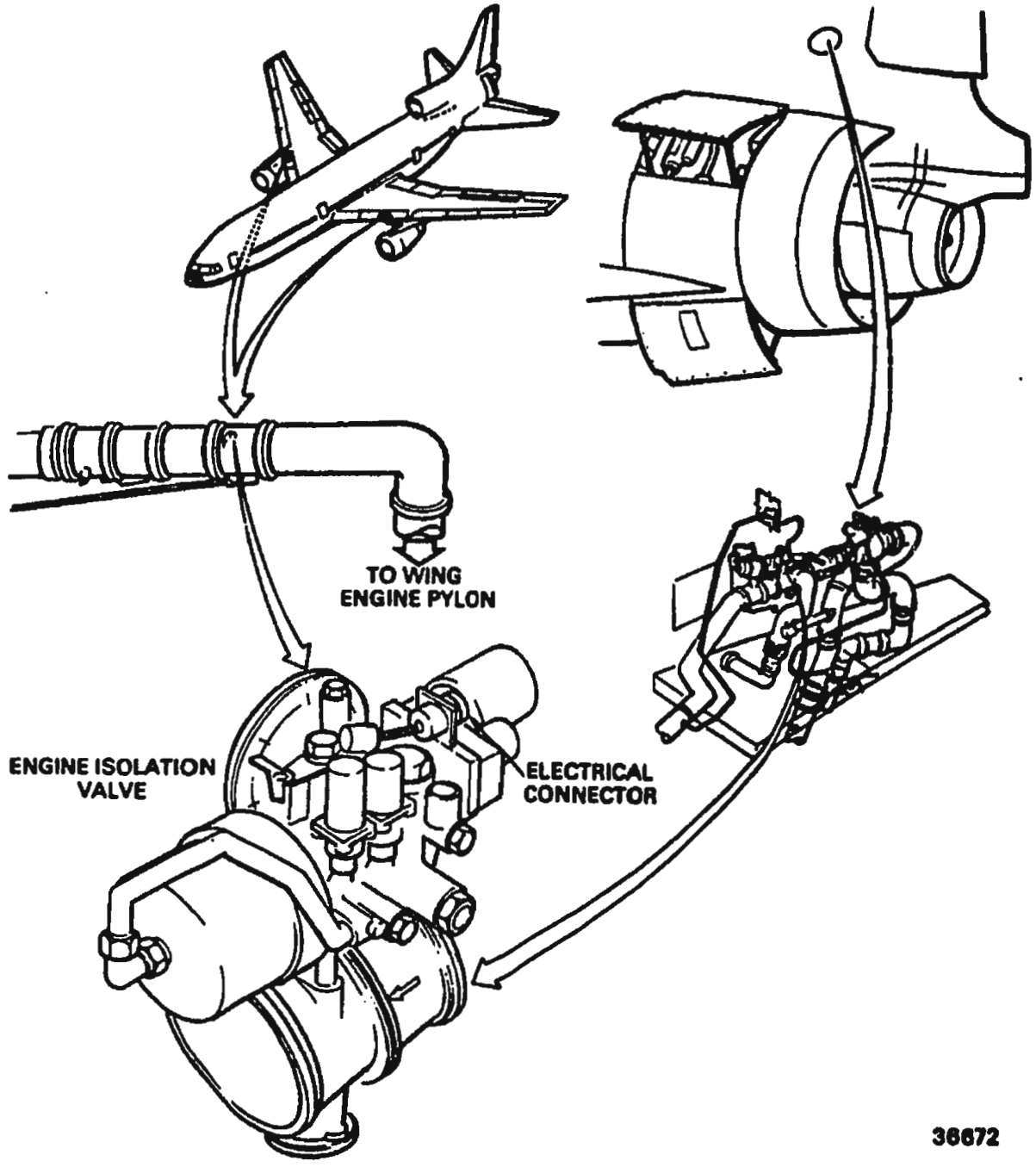
Component Locator Diagram
Fig.102 (Sheet 3 of 6)



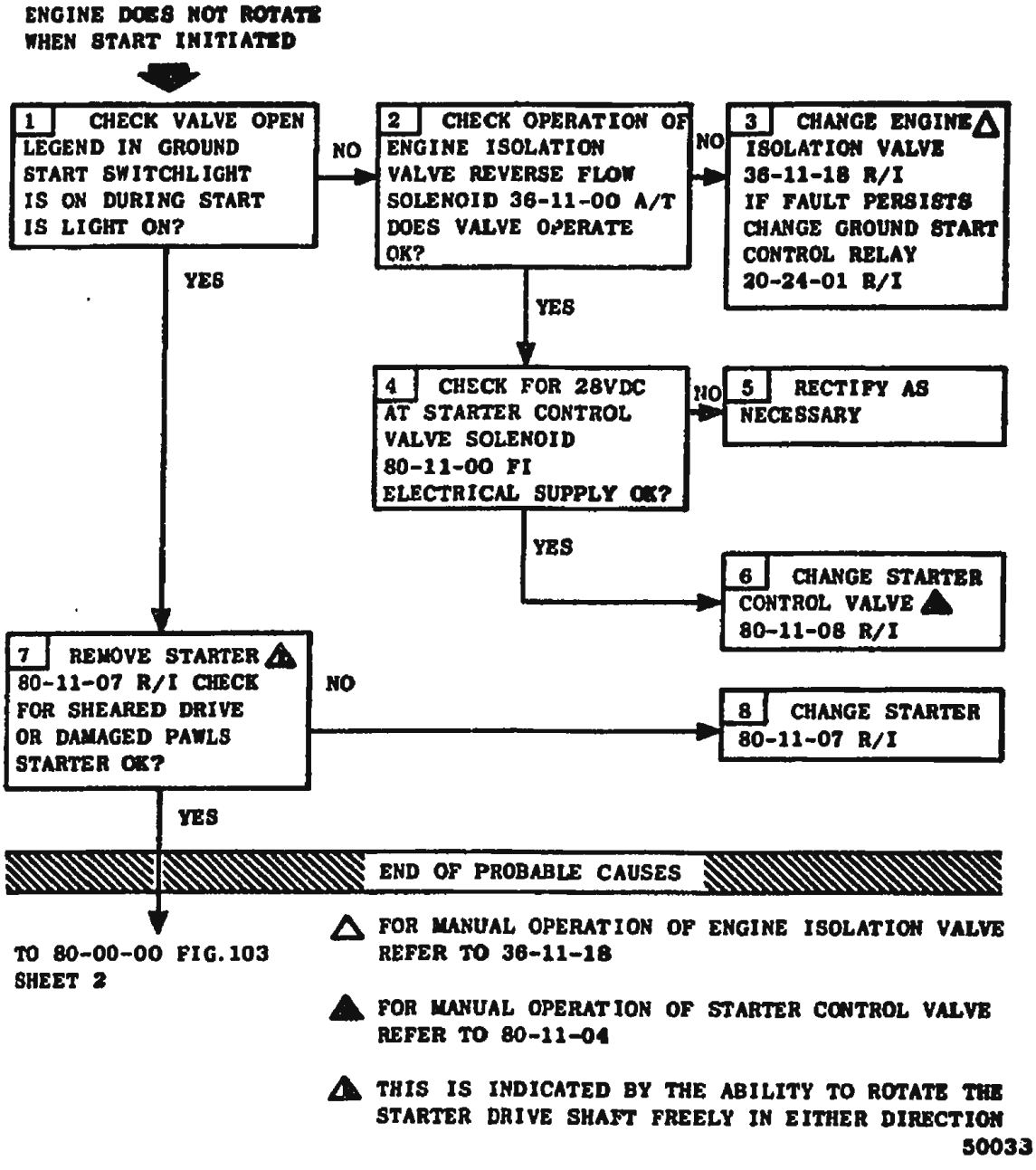
Component Locator Diagram
Fig.102 (Sheet 4 of 6)



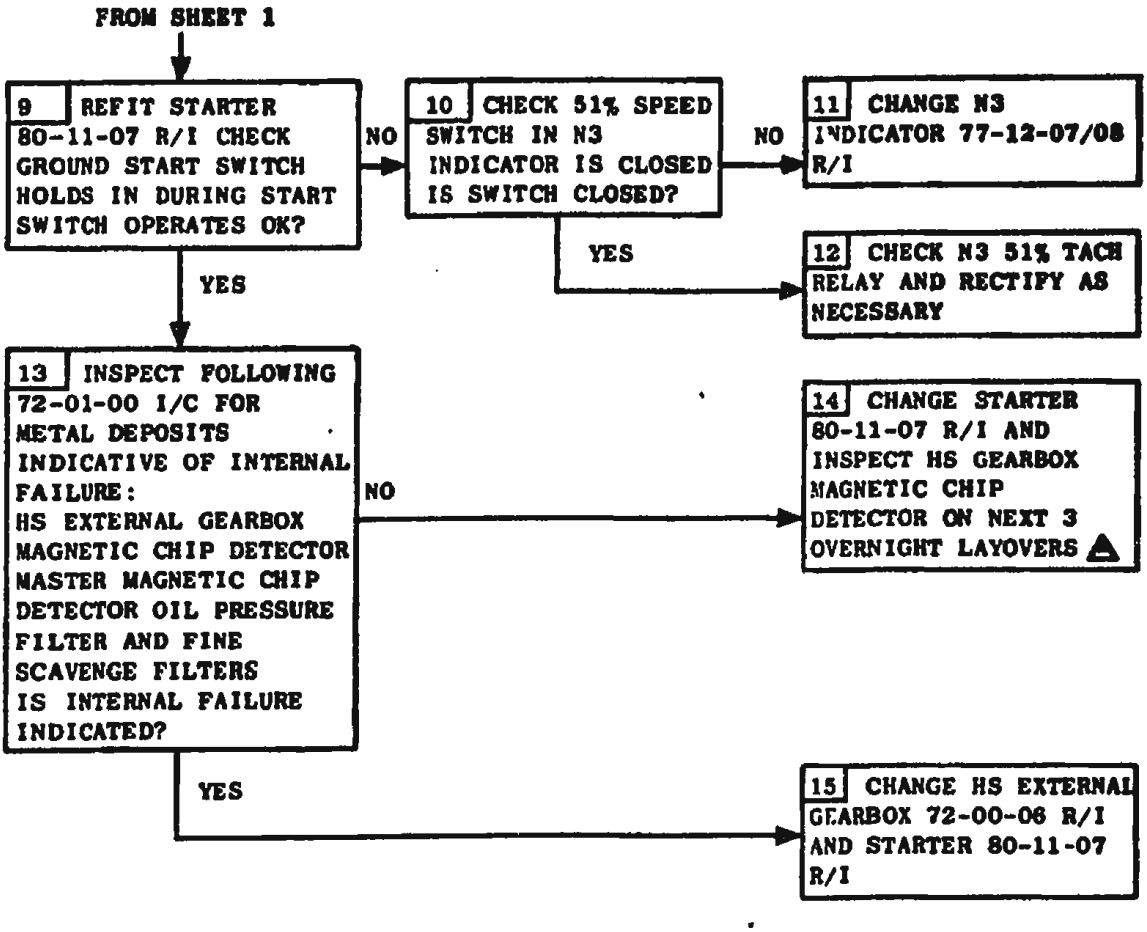
Component Locator Diagram
Fig.102 (Sheet 5 of 6)



Component Locator Diagram
Fig.102 (Sheet 6 of 6)


ENGINE DOES NOT ROTATE WHEN START INITIATED
1 CHECK VALVE OPEN LEGEND IN GROUND START SWITCHLIGHT IS ON DURING START IS LIGHT ON?
NO
YES
2 CHECK OPERATION OF ENGINE ISOLATION VALVE REVERSE FLOW SOLENOID 36-11-00 A/T DOES VALVE OPERATE OK?
NO
YES
3 CHANGE ENGINE △ ISOLATION VALVE 36-11-18 R/I IF FAULT PERSISTS CHANGE GROUND START CONTROL RELAY 20-24-01 R/I
4 CHECK FOR 28VDC AT STARTER CONTROL VALVE SOLENOID 80-11-00 FI ELECTRICAL SUPPLY OK?
NO
YES
5 RECTIFY AS NECESSARY
6 CHANGE STARTER CONTROL VALVE ▲ 80-11-08 R/I
7 REMOVE STARTER ⚠ 80-11-07 R/I CHECK FOR SHEARED DRIVE OR DAMAGED PAWLS STARTER OK?
NO
YES
8 CHANGE STARTER 80-11-07 R/I
END OF PROBABLE CAUSES
TO 80-00-00 FIG.103 SHEET 2
△ FOR MANUAL OPERATION OF ENGINE ISOLATION VALVE REFER TO 36-11-18
▲ FOR MANUAL OPERATION OF STARTER CONTROL VALVE REFER TO 80-11-04
⚠ THIS IS INDICATED BY THE ABILITY TO ROTATE THE STARTER DRIVE SHAFT FREELY IN EITHER DIRECTION
50033

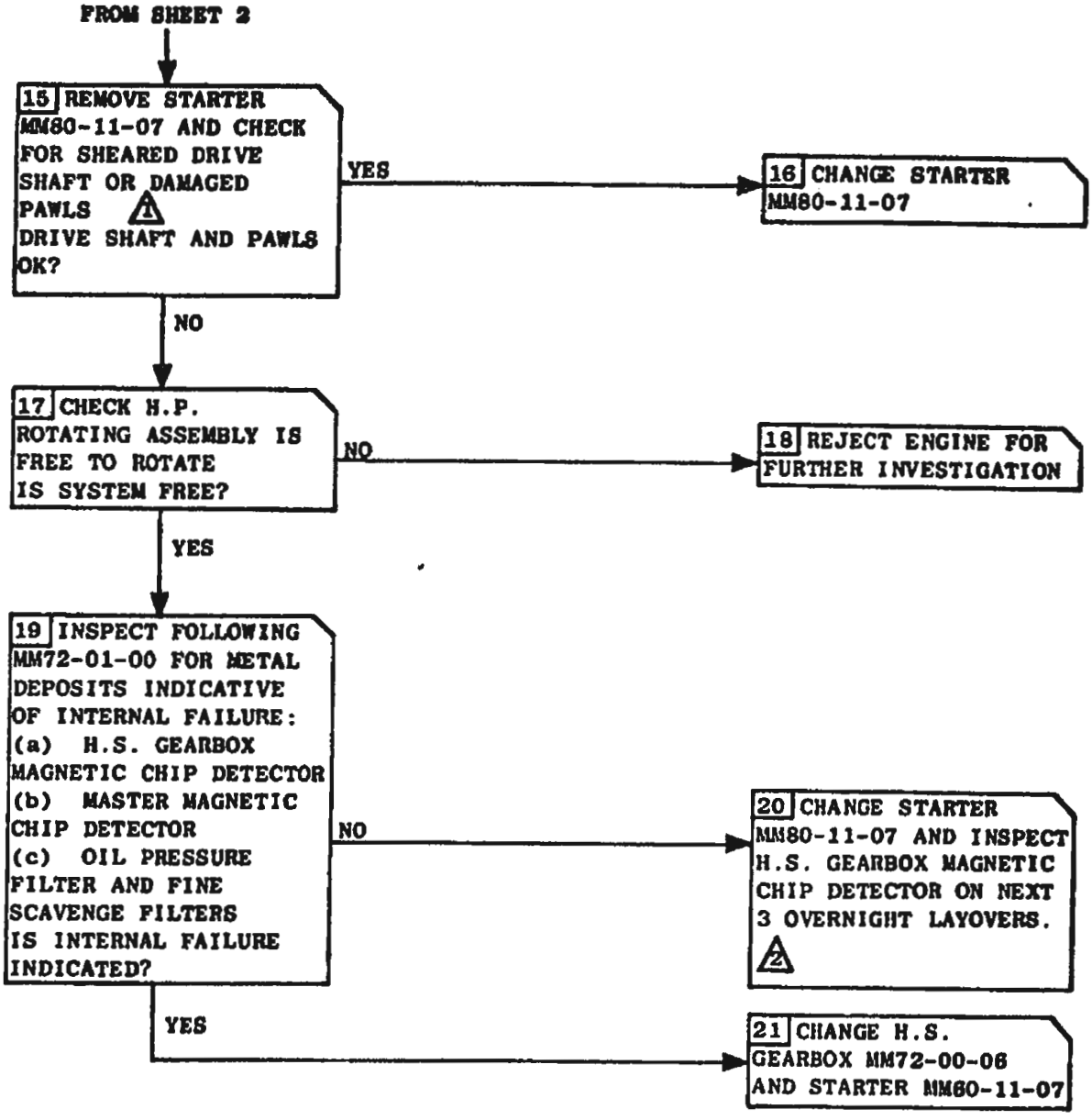
C Engine does not rotate when start initiated
C Fig.103 (Sheet 1 of 3)


FROM SHEET 1
9 REFIT STARTER 80-11-07 R/I CHECK GROUND START SWITCH HOLDS IN DURING START SWITCH OPERATES OK?
NO
10 CHECK 51% SPEED SWITCH IN N3 INDICATOR IS CLOSED IS SWITCH CLOSED?
NO
11 CHANGE N3 INDICATOR 77-12-07/08 R/I
YES
12 CHECK N3 51% TACH RELAY AND RECTIFY AS NECESSARY
YES
13 INSPECT FOLLOWING 72-01-00 I/C FOR METAL DEPOSITS INDICATIVE OF INTERNAL FAILURE: HS EXTERNAL GEARBOX MAGNETIC CHIP DETECTOR MASTER MAGNETIC CHIP DETECTOR OIL PRESSURE FILTER AND FINE SCAVENGE FILTERS IS INTERNAL FAILURE INDICATED?
NO
14 CHANGE STARTER 80-11-07 R/I AND INSPECT HS GEARBOX MAGNETIC CHIP DETECTOR ON NEXT 3 OVERNIGHT LAYOVERS ▲
YES
15 CHANGE HS EXTERNAL GEARBOX 72-00-06 R/I AND STARTER 80-11-07 R/I

▲ CONTACT MCIMD TO SET UP FOLLOW UP FOR NEXT 3 OVERNIGHT LAYOVERS

50034

C Engine does not rotate when start initiated
C Fig.103 (Sheet 2 of 3)


FROM SHEET 2
15 REMOVE STARTER MM80-11-07 AND CHECK FOR SHEARED DRIVE SHAFT OR DAMAGED PAWLS (1) DRIVE SHAFT AND PAWLS OK?
YES
16 CHANGE STARTER MM80-11-07
NO
17 CHECK H.P. ROTATING ASSEMBLY IS FREE TO ROTATE IS SYSTEM FREE?
NO
18 REJECT ENGINE FOR FURTHER INVESTIGATION
YES
19 INSPECT FOLLOWING MM72-01-00 FOR METAL DEPOSITS INDICATIVE OF INTERNAL FAILURE: (a) H.S. GEARBOX MAGNETIC CHIP DETECTOR (b) MASTER MAGNETIC CHIP DETECTOR (c) OIL PRESSURE FILTER AND FINE SCAVENGE FILTERS IS INTERNAL FAILURE INDICATED?
NO
20 CHANGE STARTER MM80-11-07 AND INSPECT H.S. GEARBOX MAGNETIC CHIP DETECTOR ON NEXT 3 OVERNIGHT LAYOVERS. (2)
YES
21 CHANGE H.S. GEARBOX MM72-00-06 AND STARTER MM80-11-07

(1) This indicated by the ability to rotate the starter drive shaft freely in either direction

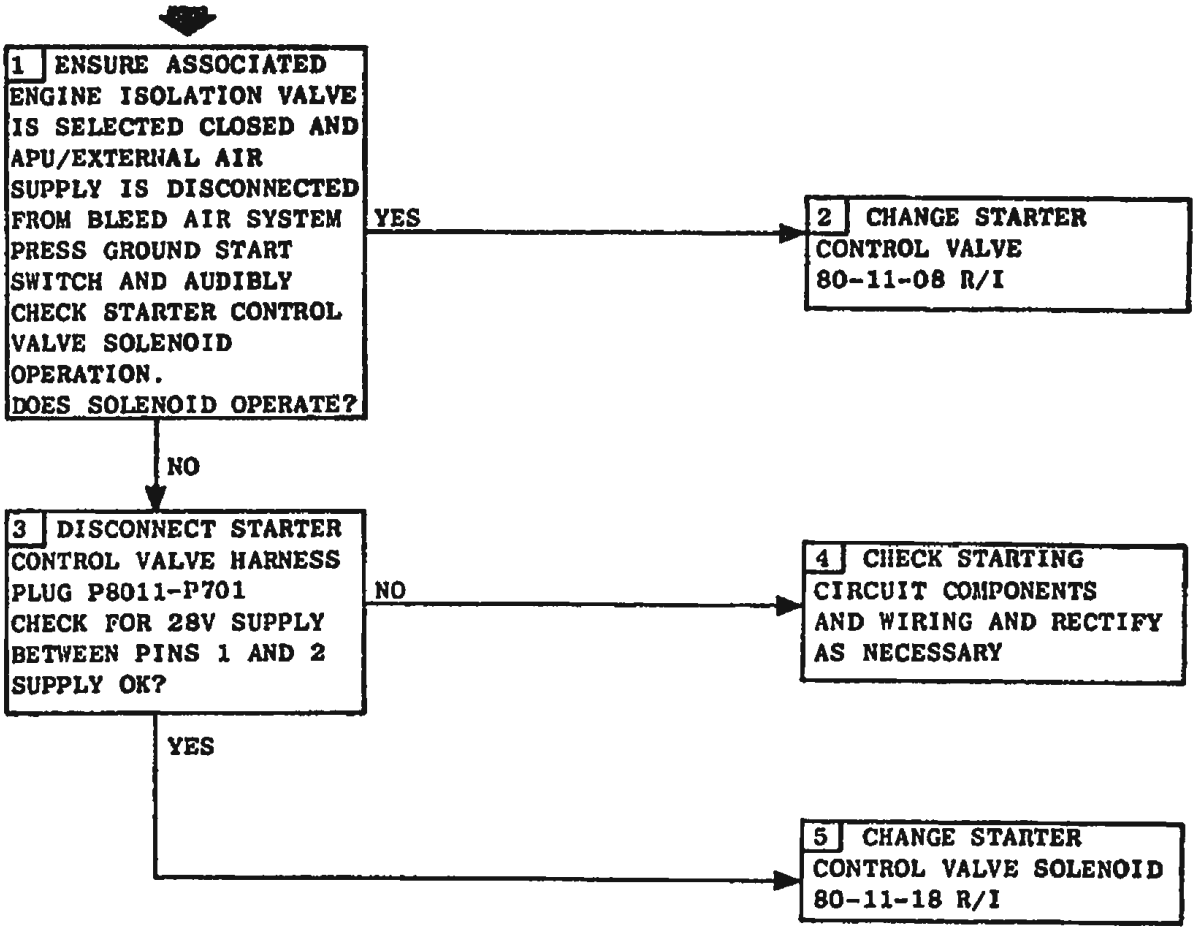
(2) Contact MCIMD to set up follow up for next 3 overnite layovers.

57550

C Engine does not rotate when start initiated
C Fig.103 (Sheet 3 of 3)

VALVE OPEN LIGHT OUT.
NO INDICATION OF N3
ROTATION WHEN START
INITIATED

PREREQUISITES: ELECTRICAL POWER 24-41-00


1 ENSURE ASSOCIATED ENGINE ISOLATION VALVE IS SELECTED CLOSED AND APU/EXTERNAL AIR SUPPLY IS DISCONNECTED FROM BLEED AIR SYSTEM PRESS GROUND START SWITCH AND AUDIBLY CHECK STARTER CONTROL VALVE SOLENOID OPERATION.
DOES SOLENOID OPERATE?
YES
2 CHANGE STARTER CONTROL VALVE 80-11-08 R/I
NO
3 DISCONNECT STARTER CONTROL VALVE HARNESS PLUG P8011-P701 CHECK FOR 28V SUPPLY BETWEEN PINS 1 AND 2
SUPPLY OK?
NO
4 CHECK STARTING CIRCUIT COMPONENTS AND WIRING AND RECTIFY AS NECESSARY
YES
5 CHANGE STARTER CONTROL VALVE SOLENOID 80-11-18 R/I

50096A

R 'Valve open' light out. No indication of N3
R rotation when start initiated
R Fig.104

Notes referred to in fault isolation procedures:

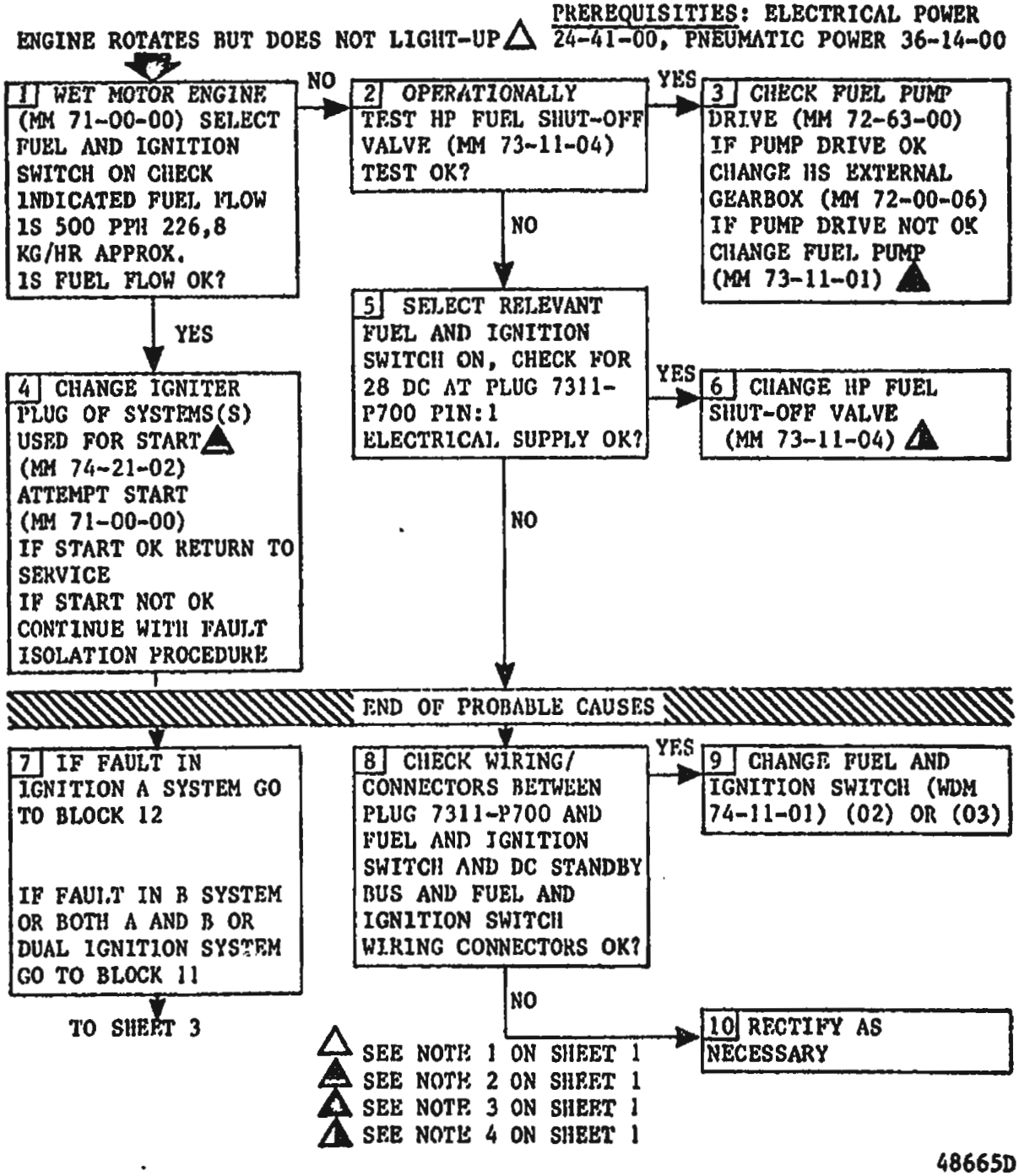
1. Intermittent failure to light-up on single ignition may be due to carbon formation on fuel spray nozzles No.8 and/or 12. Carbon forms and sheds continuously and may randomly affect engine starts. Accordingly failure to light-up on single ignition (which is satisfactory when dual ignition is used) should not require maintenance action until a number of repetative failures have occurred on same system.

2. If during change of H.E. igniter plug the centre electrode is missing, borescope inspect (72-00-00, I/C) the H.P. turbine blades.

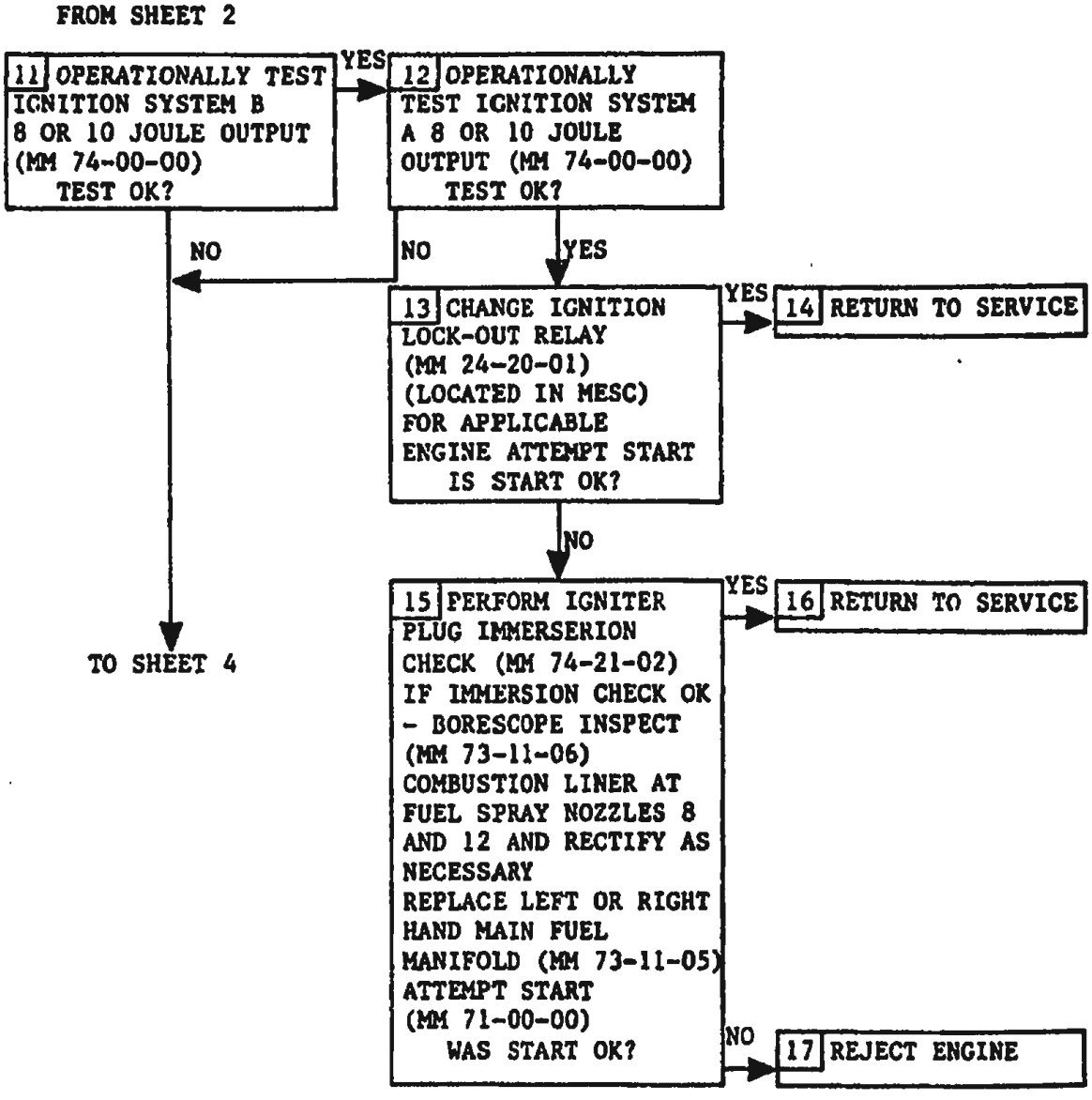
3. If on unit removal the fuel system is found to be contaminated by metal or other foreign debris the fuel filter in H.P. fuel tube to fuel spray nozzle manifold must be replaced (Ref. 73-11-09, Removal/Installation) within 750 hours.

4. If H.P. Fuel Shut-off Valve is stuck in the closed position it may be opened by gently percussing the valve with a soft faced mallet. If this is successful, the valve must be changed at first opportunity.

Engine rotates but does not 'light-up'
Fig.105 (Sheet 1 of 4)

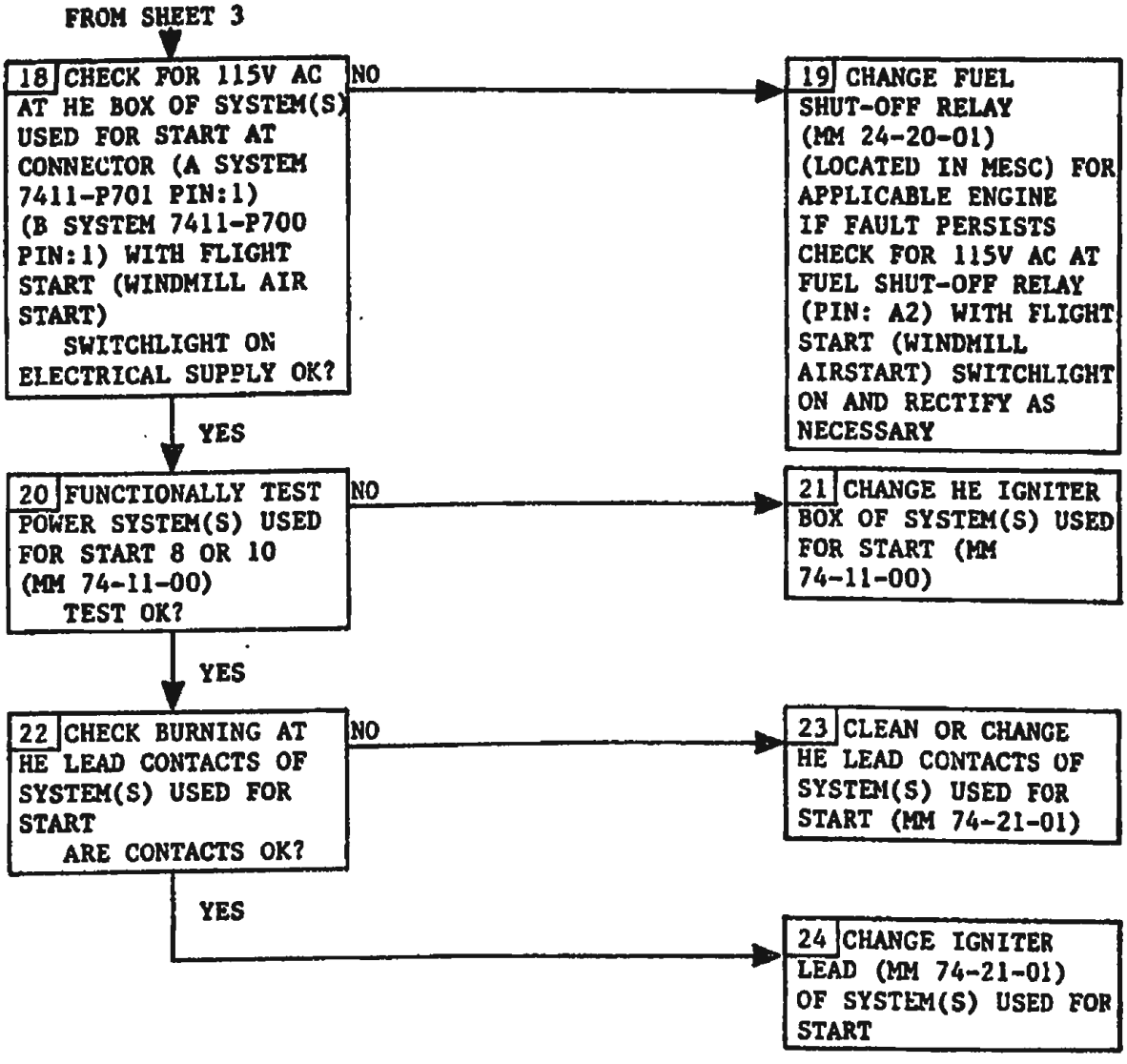

ENGINE ROTATES BUT DOES NOT LIGHT-UP △
PREREQUISITIES: ELECTRICAL POWER 24-41-00, PNEUMATIC POWER 36-14-00
1 WET MOTOR ENGINE (MM 71-00-00) SELECT FUEL AND IGNITION SWITCH ON CHECK INDICATED FUEL FLOW IS 500 PPH 226,8 KG/HR APPROX. IS FUEL FLOW OK?
NO
2 OPERATIONALLY TEST HP FUEL SHUT-OFF VALVE (MM 73-11-04) TEST OK?
YES
3 CHECK FUEL PUMP DRIVE (MM 72-63-00) IF PUMP DRIVE OK CHANGE HS EXTERNAL GEARBOX (MM 72-00-06) IF PUMP DRIVE NOT OK CHANGE FUEL PUMP (MM 73-11-01) ▲
YES
4 CHANGE IGNITER PLUG OF SYSTEMS(S) USED FOR START △ (MM 74-21-02) ATTEMPT START (MM 71-00-00) IF START OK RETURN TO SERVICE IF START NOT OK CONTINUE WITH FAULT ISOLATION PROCEDURE
NO
5 SELECT RELEVANT FUEL AND IGNITION SWITCH ON, CHECK FOR 28 DC AT PLUG 7311-P700 PIN:1 ELECTRICAL SUPPLY OK?
YES
6 CHANGE HP FUEL SHUT-OFF VALVE (MM 73-11-04) ▲
NO
END OF PROBABLE CAUSES
7 IF FAULT IN IGNITION A SYSTEM GO TO BLOCK 12
IF FAULT IN B SYSTEM OR BOTH A AND B OR DUAL IGNITION SYSTEM GO TO BLOCK 11
TO SHEET 3
8 CHECK WIRING/ CONNECTORS BETWEEN PLUG 7311-P700 AND FUEL AND IGNITION SWITCH AND DC STANDBY BUS AND FUEL AND IGNITION SWITCH WIRING CONNECTORS OK?
YES
9 CHANGE FUEL AND IGNITION SWITCH (WDM 74-11-01) (02) OR (03)
NO
10 RECTIFY AS NECESSARY
△ SEE NOTE 1 ON SHEET 1
▲ SEE NOTE 2 ON SHEET 1
△ SEE NOTE 3 ON SHEET 1
▲ SEE NOTE 4 ON SHEET 1
48665D

R R Engine rotates but does not 'light-up'
Fig.105 (Sheet 2 of 4)


FROM SHEET 2
11 OPERATIONALLY TEST IGNITION SYSTEM B 8 OR 10 JOULE OUTPUT (MM 74-00-00) TEST OK?
YES
12 OPERATIONALLY TEST IGNITION SYSTEM A 8 OR 10 JOULE OUTPUT (MM 74-00-00) TEST OK?
NO
NO
YES
13 CHANGE IGNITION LOCK-OUT RELAY (MM 24-20-01) (LOCATED IN MESC) FOR APPLICABLE ENGINE ATTEMPT START IS START OK?
YES
14 RETURN TO SERVICE
NO
15 PERFORM IGNITER PLUG IMMERSERION CHECK (MM 74-21-02) IF IMMERSION CHECK OK - BORESCOPE INSPECT (MM 73-11-06) COMBUSTION LINER AT FUEL SPRAY NOZZLES 8 AND 12 AND RECTIFY AS NECESSARY REPLACE LEFT OR RIGHT HAND MAIN FUEL MANIFOLD (MM 73-11-05) ATTEMPT START (MM 71-00-00) WAS START OK?
YES
16 RETURN TO SERVICE
NO
17 REJECT ENGINE
TO SHEET 4

48712C

R Engine rotates but does not 'light-up'
R Fig.105 (Sheet 3 of 4)

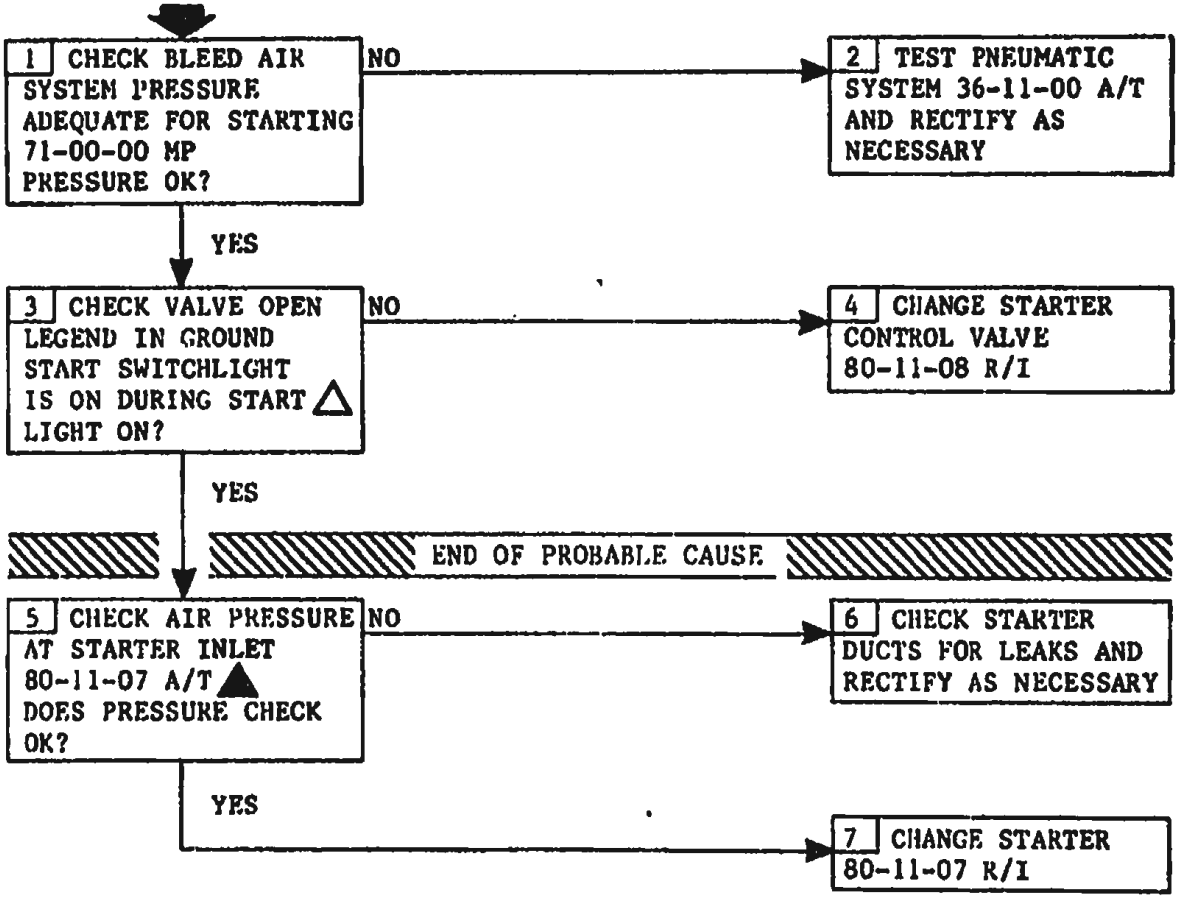

FROM SHEET 3
18 CHECK FOR 115V AC AT HE BOX OF SYSTEM(S) USED FOR START AT CONNECTOR (A SYSTEM 7411-P701 PIN:1) (B SYSTEM 7411-P700 PIN:1) WITH FLIGHT START (WINDMILL AIR START) SWITCHLIGHT ON ELECTRICAL SUPPLY OK?
NO
19 CHANGE FUEL SHUT-OFF RELAY (MM 24-20-01) (LOCATED IN MESC) FOR APPLICABLE ENGINE IF FAULT PERSISTS CHECK FOR 115V AC AT FUEL SHUT-OFF RELAY (PIN: A2) WITH FLIGHT START (WINDMILL AIRSTART) SWITCHLIGHT ON AND RECTIFY AS NECESSARY
YES
20 FUNCTIONALLY TEST POWER SYSTEM(S) USED FOR START 8 OR 10 (MM 74-11-00) TEST OK?
NO
21 CHANGE HE IGNITER BOX OF SYSTEM(S) USED FOR START (MM 74-11-00)
YES
22 CHECK BURNING AT HE LEAD CONTACTS OF SYSTEM(S) USED FOR START ARE CONTACTS OK?
NO
23 CLEAN OR CHANGE HE LEAD CONTACTS OF SYSTEM(S) USED FOR START (MM 74-21-01)
YES
24 CHANGE IGNITER LEAD (MM 74-21-01) OF SYSTEM(S) USED FOR START

48713C

R Engine rotates but does not 'light-up'
R Fig.105 (Sheet 4 of 4)

UNABLE TO ACHIEVE MOTORING SPEED (25% N3 APPROX)

PREREQUISITES: ELECTRICAL POWER 24-41-00
PNEUMATIC POWER 36-14-00


1 CHECK BLEED AIR SYSTEM PRESSURE ADEQUATE FOR STARTING 71-00-00 MP PRESSURE OK?
NO
2 TEST PNEUMATIC SYSTEM 36-11-00 A/T AND RECTIFY AS NECESSARY
YES
3 CHECK VALVE OPEN LEGEND IN GROUND START SWITCHLIGHT IS ON DURING START LIGHT ON? △
NO
4 CHANGE STARTER CONTROL VALVE 80-11-08 R/I
YES
END OF PROBABLE CAUSE
5 CHECK AIR PRESSURE AT STARTER INLET 80-11-07 A/T ▲ DOES PRESSURE CHECK OK?
NO
6 CHECK STARTER DUCTS FOR LEAKS AND RECTIFY AS NECESSARY
YES
7 CHANGE STARTER 80-11-07 R/I

△ A VISUAL CHECK OF STARTER CONTROL VALVE POSITION INDICATOR IS REQUIRED TO ENSURE VALVE IS FULLY OPEN.

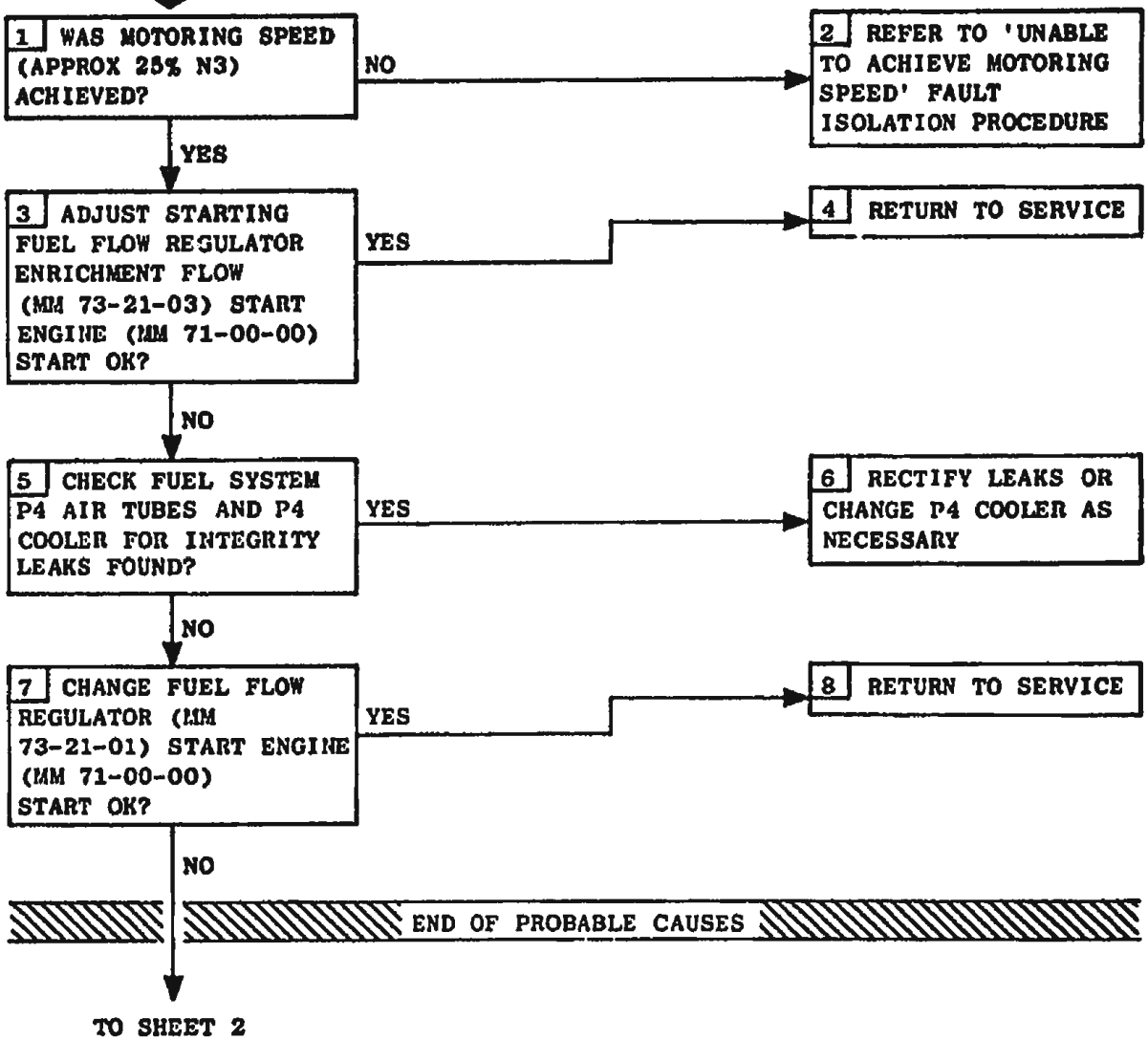
▲ AIR PRESSURE AT STARTER INLET SHOULD NOT BE MORE THAN 6 P.S.I.G. BELOW BLEED AIR SYSTEM PRESSURE.

48714B

R Unable to achieve motoring speed (25% N3 approximately)
R Fig.106

HUNG START ENGINE SLOW TO ACCELERATE TO GROUND IDLE

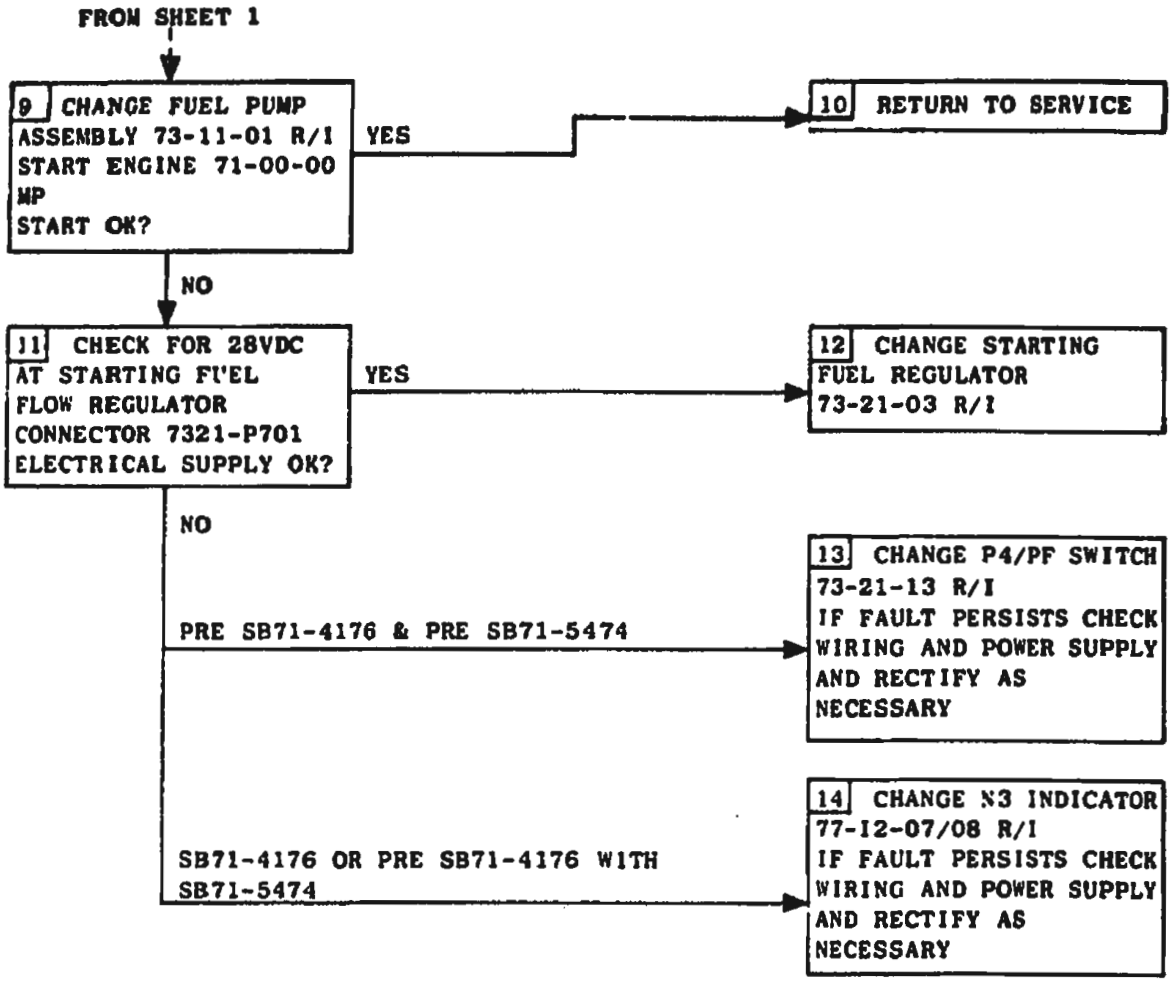
PREREQUISITES: ELECTRICAL POWER 24-41-00, PNEUMATIC POWER 36-14-00.


1 WAS MOTORING SPEED (APPROX 25% N3) ACHIEVED?
NO
2 REFER TO 'UNABLE TO ACHIEVE MOTORING SPEED' FAULT ISOLATION PROCEDURE
YES
3 ADJUST STARTING FUEL FLOW REGULATOR ENRICHMENT FLOW (MM 73-21-03) START ENGINE (MM 71-00-00) START OK?
YES
4 RETURN TO SERVICE
NO
5 CHECK FUEL SYSTEM P4 AIR TUBES AND P4 COOLER FOR INTEGRITY LEAKS FOUND?
YES
6 RECTIFY LEAKS OR CHANGE P4 COOLER AS NECESSARY
NO
7 CHANGE FUEL FLOW REGULATOR (MM 73-21-01) START ENGINE (MM 71-00-00) START OK?
YES
8 RETURN TO SERVICE
NO
END OF PROBABLE CAUSES

TO SHEET 2

48715R

R Hung start/Engine slow to accelerate to ground idle
R Fig.107 (Sheet 1 of 2)


FROM SHEET 1
9 CHANGE FUEL PUMP ASSEMBLY 73-11-01 R/I START ENGINE 71-00-00 MP START OK?
YES
10 RETURN TO SERVICE
NO
11 CHECK FOR 28VDC AT STARTING FUEL FLOW REGULATOR CONNECTOR 7321-P701 ELECTRICAL SUPPLY OK?
YES
12 CHANGE STARTING FUEL REGULATOR 73-21-03 R/I
NO
PRE SB71-4176 & PRE SB71-5474
13 CHANGE P4/PF SWITCH 73-21-13 R/I IF FAULT PERSISTS CHECK WIRING AND POWER SUPPLY AND RECTIFY AS NECESSARY
SB71-4176 OR PRE SB71-4176 WITH SB71-5474
14 CHANGE N3 INDICATOR 77-12-07/08 R/I IF FAULT PERSISTS CHECK WIRING AND POWER SUPPLY AND RECTIFY AS NECESSARY

48716

Hung start/Engine slow to accelerate to ground idle
Fig.107 (Sheet 2 of 2)

FAILURE TO RELIGHT UNTIL ALTITUDE REDUCED

PREREQUISITES: NONE

1	CHANGE H.E. IGNITER PLUGS MM 74-21-02 AND CLEAN STARTING FUEL FLOW REGULATOR STRAINER MM 73-21-03

35217B

Failure to relight until altitude reduced
Fig.108

CRANKING SYSTEM - INSPECTION AND CHECK

1. Referenced Procedures

12-12-11	Engine Starter Oil - Replenishing
71-11-00	Cowling, Engines No. 1 and 3 - Maintenance Practices
71-12-00	Cowling, Engine No. 2 - Maintenance Practices
80-11-07	Engine Pneumatic Starter - Inspection and Check

2. Inspection/Check

A. At flight station, zone 210, tag applicable power control lever for non-operation.

B. Open hinged cowl panels 413 and 414 for engine No. 1, 423 and 424 for engine No. 3, or 433 and 434 for engine No. 2, to gain access to cranking system components (Ref. 71-11-00 or 71-12-00).

C. Inspect and check engine pneumatic starter (Ref. 80-11-07).

D. Inspect starter housing adapter for cracks, oil leakage, and loose attaching hardware.

E. Inspect and check engine pneumatic starter (Ref. 80-11-07).

F. Inspect starter ducting between starter control valve and engine pneumatic starter for dents, cracks, and signs of leakage at joints.

G. Check that couplings and clamps are secure and in good condition.

H. Inspect and check starter control valve for cracks, corrosion at electrical connector and microswitch, and loose screws in valve housing.

I. Check action of manual override button for free movement.

J. Check upper manual operation hex fitting and position-indicator lever to verify that arrow points to embossed letter S on actuator housing.

K. Check for broken butterfly disk shaft by holding upper manual operation hex fitting and lever while attempting to

turn lower manual operation hex fitting with fingers. Free movement must not exist.

L. Check control valve wire harness for broken wires or damaged insulation.

M. Check starter sight gage for correct oil level (Ref. attached placard). Service starter, if required (Ref. 12-12-11).

N. Close cowling (Ref. 71-11-00 or 71-12-00).

O. Remove tags installed in Step 2A.

R

ENGINE STARTING SYSTEM - DESCRIPTION AND OPERATION

1. General

The engine starting system (Ref. Fig. 1), which can be used for either ground or air starts, consists of an engine-mounted pneumatic starter motor and an engine starter control valve for each engine, zones 412, 422, and 432, plus associated ducting and electrical control components. These units provide the impulse to rotate the engine high-pressure (HP) compressor rotor to speeds at which engine light-off can occur. The starter continues to assist engine acceleration up to the starter cutout speed. While the primary purpose of cranking units in the starting system is to start the engines on the ground, the starting system can provide the necessary assist for an in-flight restart when an engine has shut down for any reason. If the windmilling speeds of the low-pressure (LP), intermediate-pressure (IP), and HP compressors are inadequate to promote ignition of the fuel/air mixture, cross-bleed air pressure from an operating engine or air pressure supplied by the APU (Ref. 49-00-00) can be directed to the cranking system to accomplish a successful starter-assisted flight restart.

Each of the three engines has a starter mounted on the forward face of the external high-speed gearbox. The starter is attached by a combination of mated splines and a quick attach-detach (QAD) clamp. A starter control valve, located on the lower right side of the LP compressor case, is supported by the starter ducting. The valve is attached by double T-bolt V-band (Avica) couplings. An identical coupling is used to attach the starter ducting to the engine bleed air duct (downstream from the engine bleed air mixing ejector).

Three GROUND START switchlights, three FLIGHT START switchlights, one GND START RELEASE switchlight, and one CONTINUOUS IGNITION switchlight are mounted on the pilots overhead ENGINE START panel, zone 210 (Ref. Fig. 2). The GROUND START switchlights are solenoid-held, four-pole, double-throw units. The FLIGHT START and CONTINUOUS IGNITION switchlights are alternate-action, four-pole, double-throw units. The GND START RELEASE switchlight is a momentary-contact, four-pole, double-throw unit. Three FUEL AND IGNITION switches are mounted on the pilots center console, zone 210. These switches are four-pole, triple-throw, toggle units with OFF, ON, and momentary ENRICH positions, that complete circuits for the fuel and ignition systems (Ref. Fig. 2).

Switches within the N3 engine shaft speed indicators (Ref. 77-12-00) automatically terminate starting functions at the required engine speeds.

Engine IP and HP bleed air ducting systems and starter ducting systems are arranged so that any engine can supply air pressure to the other engines for cranking. The gas turbine APU may be used to supply air pressure to an engine, or a ground air supply source can provide air pressure through external connection points.

All ducting is designed for high pressures and high temperatures. Sections are coupled with double T-bolt V-band couplings, while gimbal joints, compensators, and bellows-type flex joints counteract expansion/contraction and flexing. Supports attach the ducting to adjacent structure.

2. Operation

Engine cranking on the ground is normally performed with air pressure from the APU. A pneumatic ground power truck or a pneumatic starter air supply cart may also be used to provide HP air (Ref. 36-10-00) for engine cranking. Cross-bleed pressurized air from an operating engine may be used to crank the remaining engines on the ground. In-flight restart assistance is provided by the cross-bleed capability or from APU output.

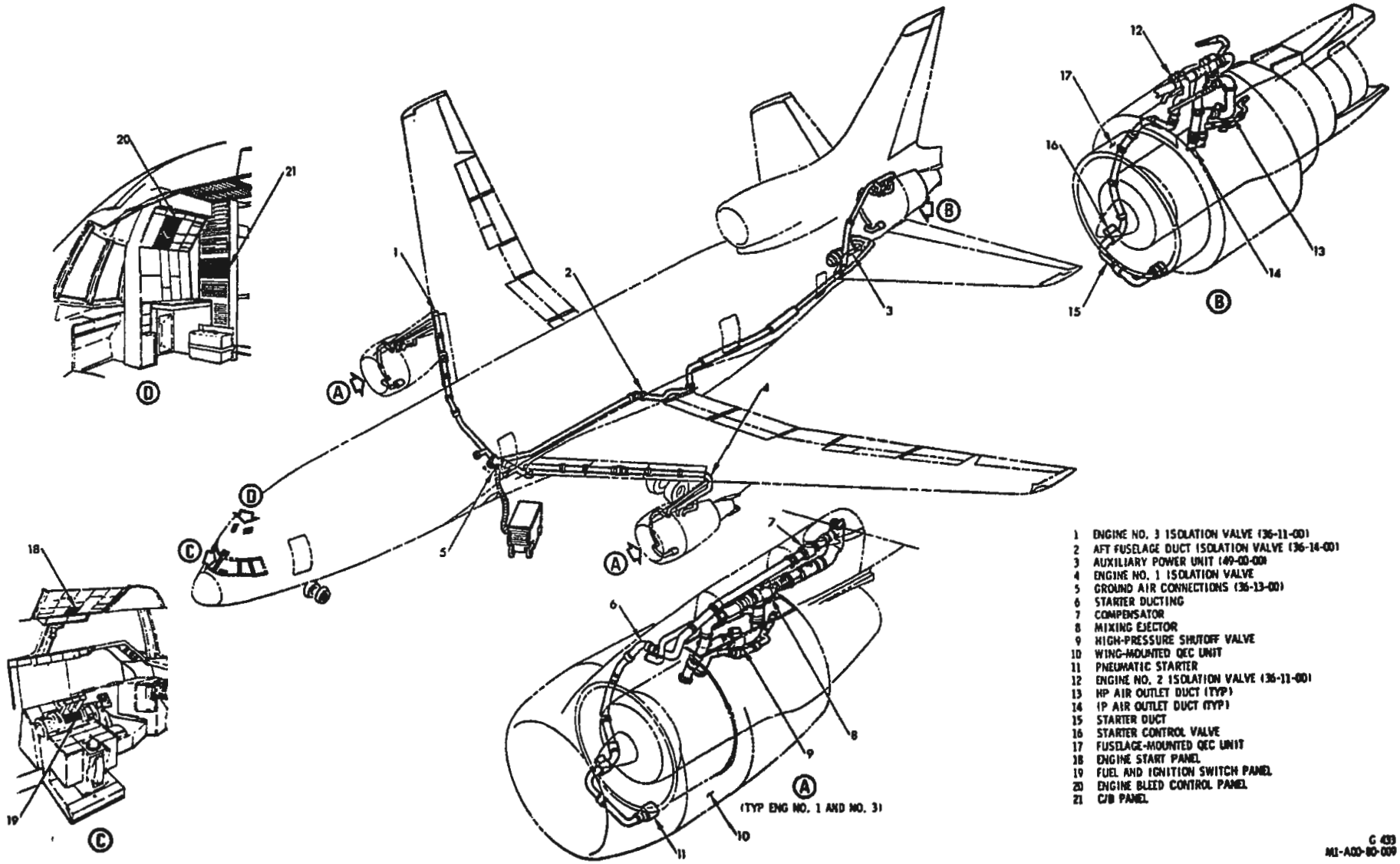
A. To Start Engine on Ground (Ref. 71-00-00, Adjustment and Test, for engine start procedure)

A typical ground start is performed using the APU. An alternate method is to use a ground air supply plugged into the external power receptacles on and near the fuselage centerline, zone 137. Verification of proper positioning of start and ignition switches, circuit breakers, engine-driven hydraulic pump switches, fuel tank boost pump switches, and availability of a starter air supply must be performed before beginning engine start procedures. With the pneumatic system bleed air ducts pressurized to approximately 40 psia at a temperature of 350 degrees F (not in excess of 500 degrees F), power control levers positioned for idle, and with 28V dc/200V ac power available (Ref. Fig. 3), engine cranking may be initiated.

R R Actuation of the applicable GROUND START switchlight (Ref. Fig. 2) results in the following:

(1) Actuation of the HP3 bleed valve solenoid which allows the respective engine HP3 starting bleed valve to exhaust HP3 air into the fan stream.

(2) Actuation of the ground start and start control relays. This action energizes the engine isolation valve and starter air valve solenoid; as the starter control

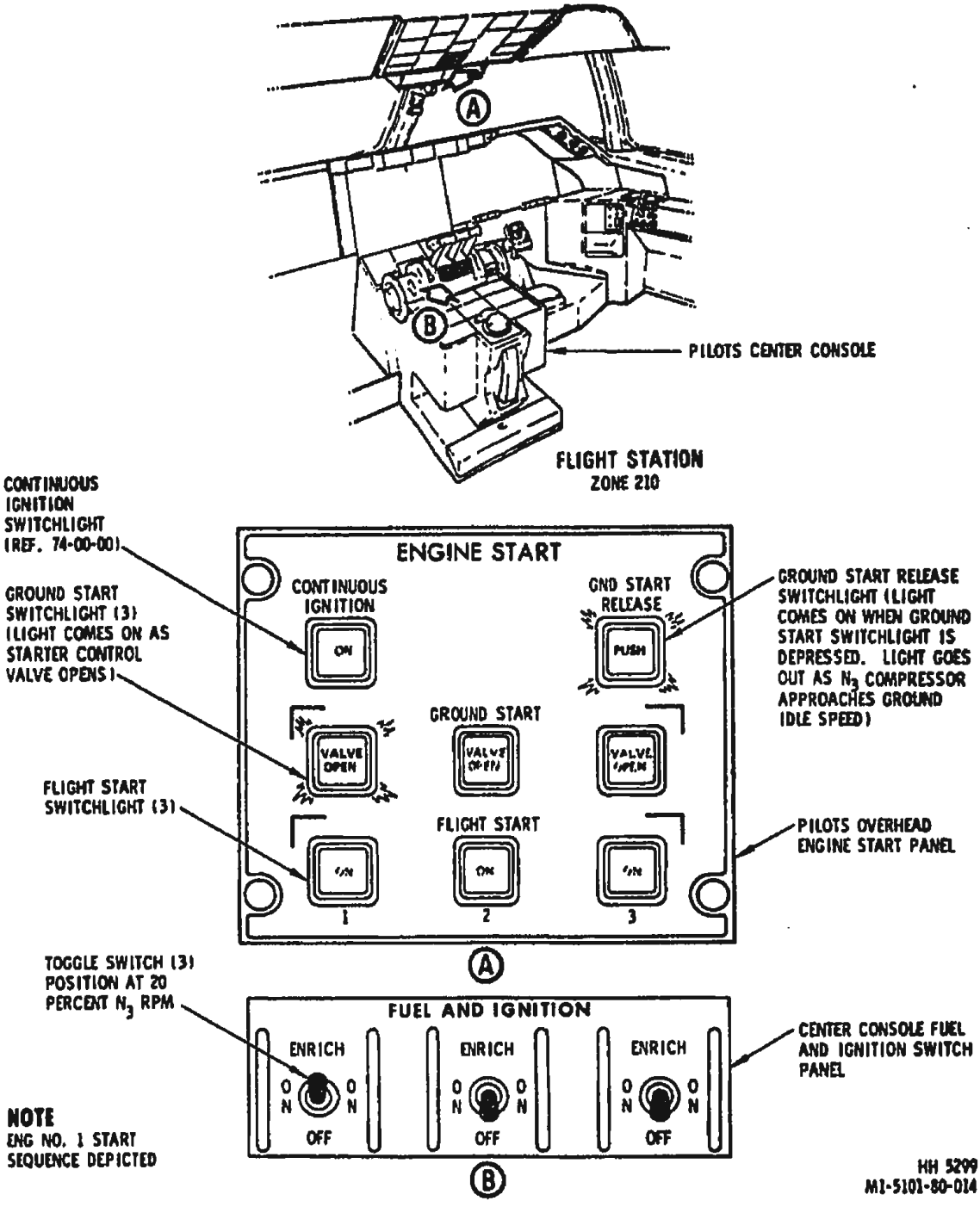

1 ENGINE NO. 3 ISOLATION VALVE (36-11-00)
2 AFT FUSELAGE DUCT ISOLATION VALVE (36-14-00)
3 AUXILIARY POWER UNIT (49-00-00)
4 ENGINE NO. 1 ISOLATION VALVE
5 GROUND AIR CONNECTIONS (36-13-00)
6 STARTER DUCTING
7 COMPENSATOR
8 MIXING EJECTOR
9 HIGH-PRESSURE SHUTOFF VALVE
10 WING-MOUNTED QEC UNIT
11 PNEUMATIC STARTER
12 ENGINE NO. 2 ISOLATION VALVE (36-11-00)
13 HP AIR OUTLET DUCT (TYP)
14 IP AIR OUTLET DUCT (TYP)
15 STARTER DUCT
16 STARTER CONTROL VALVE
17 FUSELAGE-MOUNTED QEC UNIT
18 ENGINE START PANEL
19 FUEL AND IGNITION SWITCH PANEL
20 ENGINE BLEED CONTROL PANEL
21 C/B PANEL
(TYP ENG NO. 1 AND NO. 3)
G 433
M1-A00-80-009

R
R

Engine Starting System
Figure 1

EFFECTIVITY: ALL

0018



R Engine Start Switch Panels
R Figure 2

valve opens, the light in the start switchlight will come on to illuminate the VALVE OPEN legend.

(3) Actuation of the minimum variable metering (VMO) orifice area stop solenoid which effects a redatum of the minimum fuel flow stop on the engine fuel flow regulator.

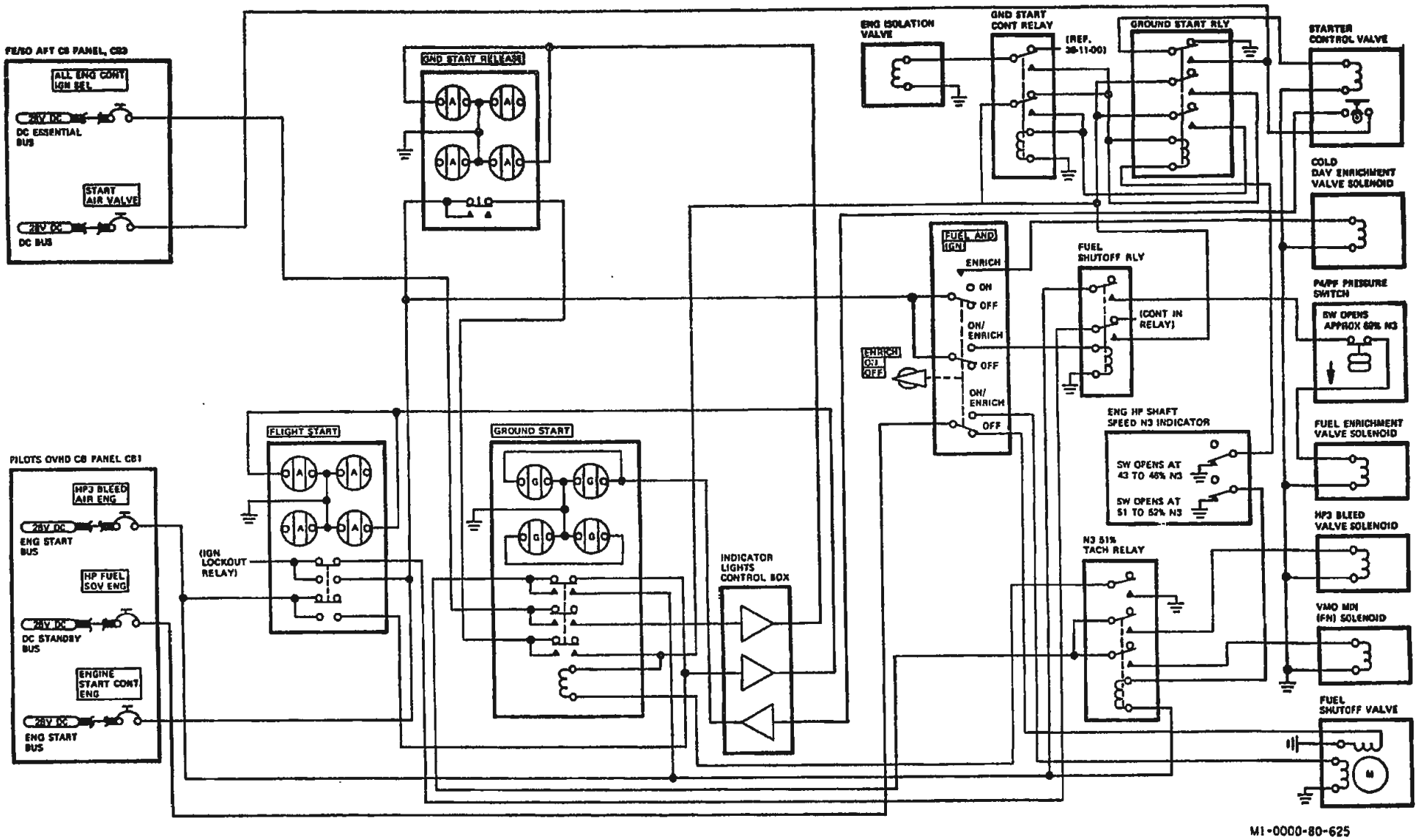
(4) Energizing the holding coil in the start switch.

(5) Illumination of the lens in the GROUND START release switchlight.

With pressurized air entering the starter, the gear train accelerates rapidly. Cranking torque is transmitted through the external gearbox drive shaft to a bevel gear on the HP compressor module to rotate the compressor. At approximately 20 percent on the N3 (HP) shaft speed indicator, the applicable FUEL and IGNITION toggle switch on the pilots center console, zone 210, is placed in the ON position. This action results in the actuation of the fuel and ignition relay and opening of the fuel shutoff valve. Actuation of the fuel and ignition relay actuates the starting fuel enrichment solenoid valve which opens a controlled fuel flow by-pass circuit, in parallel with the fuel flow regulator to augment starting fuel flow when the engine fuel shut off valve is open. Fuel and ignition relay contacts also complete a circuit actuating the ignition lockout relay which completes the ground start high energy ignition circuit to one or both igniter plugs, depending on the previously selected position of the start ignition selector switch.

In the event additional fuel flow is required to achieve a satisfactory start with cold ambient temperature conditions, the FUEL and IGNITION switch is actuated to the ENRICH position. This is a momentary position that supplies electrical power to the cold day fuel enrichment solenoid valve for providing additional fuel flow to augment the primary engine start fuel flow.

With light-off, engine rpm increases rapidly and at 43 to 46 percent N3 (4600 to 4900 rpm) a switch in the N3 indicator actuates to deenergize the ground start relay. Consequently, the starter valve closes turning the light off in the GROUND START switchlight and removing power from the engine isolation valve. The starter air valve closing also terminates air flow to the pneumatic starter and the starter clutch disengages. Engine acceleration to 51 percent N3 (5400 to 5500 rpm) actuates a second switch in the N3 indicator which deenergizes the N3 (51 percent) tach relay.

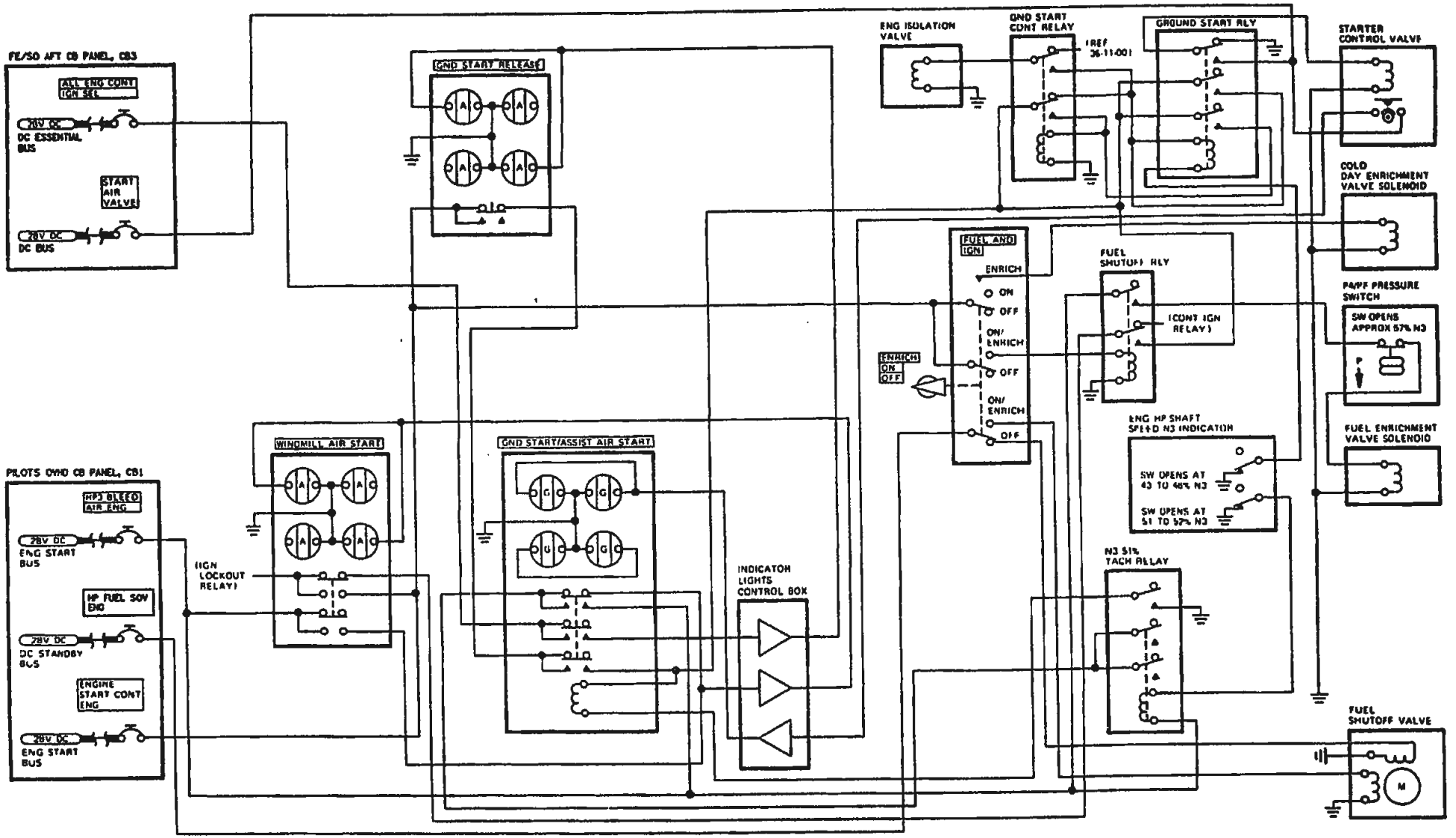


MI-0000-80-625

R Engine Start Simplified Schematic
R Figure 3

EFFECTIVITY: EN ..NES WITHOUT RR SB71-5474

001B



M1-0000-80-626

R Engine Start Simplified Schematic
R Figure 3

EFFECTIVITY: ENGINES WITH RR SB71-5474

001B

Open contacts of the tach relay results in deactivation of the HP3 bleed valve solenoid allowing the HP3 bleed valve to close, deenergizing the minimum VMO area stop solenoid, and removing power from the ground start switch hold-in coil, allowing the start switch to deactuate to the off position and deenergize the start control relay.

Deactuation of the start switch results in deenergizing the ignition lockout relay which removes power from the high energy ignition units and enables activation of the low energy continuous ignition system. It also results in removing power from the light in the GND START RELEASE switchlight.

In the event the cold day fuel enrichment system was utilized, the system is deactivated on command during the start sequence by releasing the FUEL and IGNITION switch to the ON position. Engine acceleration continues until the ground idle power level, as controlled by the engine fuel flow regulator, is achieved.

R The starting fuel enrichment solenoid is deenergized by the
R engine pressure ratio (P4/PF) switch actuation at slightly
R less than 68 percent N3 prior to flight idle.

B. To Interrupt Start Sequence

The GND START RELEASE switchlight can interrupt the starting sequence at HP compressor speeds below 43 percent of maximum rpm. When the ground start procedure is initiated, the GND START RELEASE switchlight PUSH legend is illuminated. The light goes out when the starting sequence ends. If it becomes necessary to interrupt the normal start sequence at less than 43 percent N3 rpm, depressing the GND START RELEASE switchlight and placing the affected FUEL and IGNITION toggle switch in the OFF position will end starting functions immediately. These actions cause the starter control valve to close, interrupt ignition power, and cut off fuel flow.

C. To Motor Engine

Engine motoring may be performed, using either APU, crossbleed, or ground air supply to clear fuel from the combustion chamber, to accomplish integrated drive generator (IDG) motoring (following unit replacement), or for other power plant maintenance tasks. Before motoring of the engine is attempted, ignition circuit breakers must be opened, FUEL and IGNITION toggle switches must be in the OFF position, and power control levers on the center console must be in the 0 (idle cutoff) position. With the air supply source connected, depressing the GROUND START

switchlight on the ENGINE START panel supplies power to the starter control valve solenoid to open the starter control valve. Motoring is discontinued by depressing the GND START RELEASE switchlight. Maximum ground motoring N3 compressor shaft speed attainable is approximately 2500 rpm with APU air.

3. Engine Pneumatic Starter

A. Description

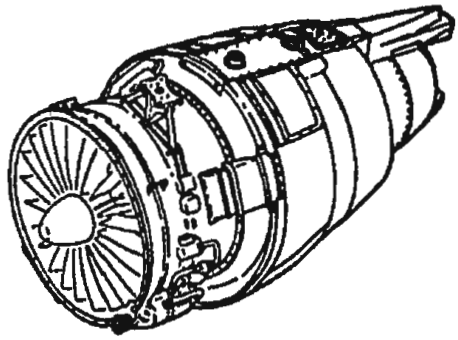
The engine starter is a pneumatically driven single-stage turbine unit that rotates the turbofan engine HP system module to the required speed for engine start. Principal components of the starter are shown in Fig. 4.

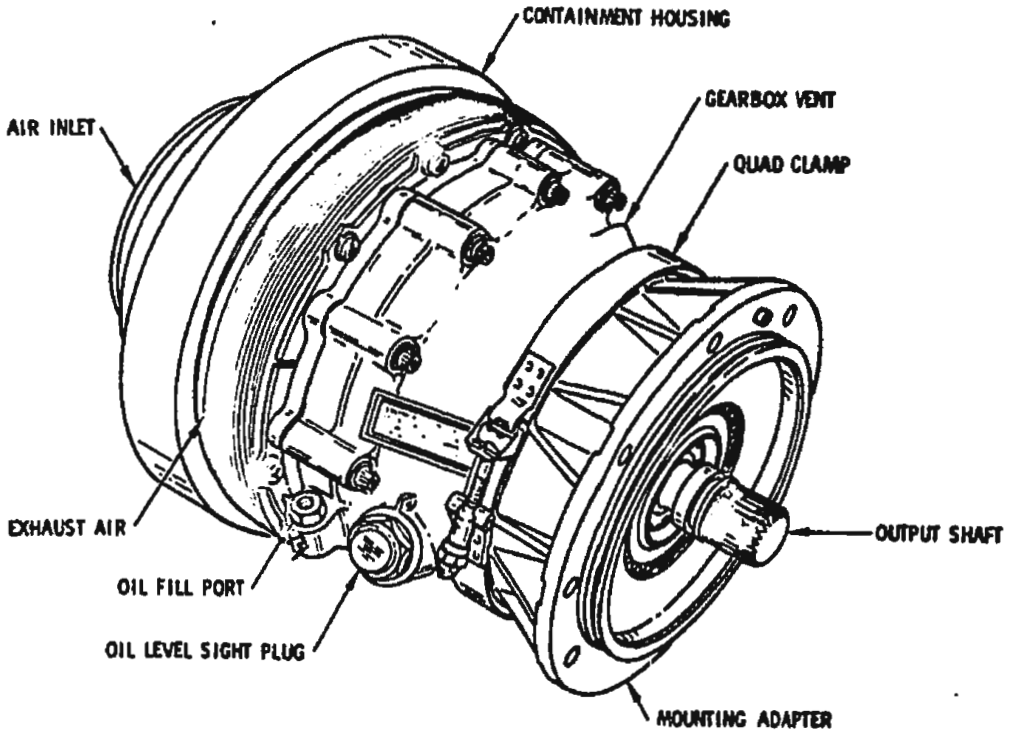
The turbine housing has a thick containment shroud surrounding the turbine rotor to reduce the effects of a rotor failure by containing broken parts within the starter envelope. The rotor assembly, including the shaft, is machined from a titanium forging. The rotor has a maximum free-running speed of 86,400 rpm without yield.

A two-stage clustered 10.45 to 1 reduction gear set drives the clutch ratchet through the ring gear. Clutch assembly pawls are spring-loaded to engage the ratchet and ensure that driving contact is maintained at speeds below the cutout speed range. The output shaft is driven through the clutch assembly.

The starter is secured to an engine gear case adapter with a stainless steel quick attach-detach (QAD) clamp after engagement of an indexed series of splines. A controlled-shear section is embodied in the design of the clutch shaft to prevent damage to the engine external gearbox in the event of a shaft overload. The clutch output shaft is in constant mesh with the engine external gearbox input shaft. The input shaft rotates whenever the HP compressor is rotating.

Studs and external-wrenching nuts mate the starter adapter housing to the gearbox. An indexing pin is located at the 12-o'clock position on the adapter housing flange. Since the starter clutch shaft splines are lubricated by the engine oil system, preformed packings are installed on the shaft and on the pilot hub. The starter has a magnetic drain plug that may be removed for inspection without loss of starter oil. Oil capacity is 9 fluid ounces. Lubricating oil is replenished through a gravity-feed well or a quick-disconnect (QD) oil coupling.





M1-0102-80-001

Pneumatic Starter
Figure 4

B. Operation

Pressurized air from the APU, a ground air supply source, or from a power plant that has already been started enters the 4.5-inch-diameter inlet duct to drive the turbine rotor at a typical pressure of 40 psia and an inlet temperature of 350 degrees F. Air passing through the turbine exhausts through the baffled ports (REf. Fig. 4). The rotor accelerates to drive the reduction gear and clutch mechanism. The clutch pawls are spring-loaded and clutch engagement is maintained to starter cutout speed.

Maximum starting torque at 50 psia air pressure is 800 lb ft. The starter is capable of accelerating the RB211 engine from a static condition to starter cutout speed(43-46 percent N3) using APU air source, assuming normal engine light-off. When the high-pressure airflow is interrupted at starter cutout speed, starter torque drops immediately and the engine continues to accelerate. The spring-loaded clutch pawls are pulled outward as centrifugal force overcomes spring tension at 46-53 percent N3 (the clutch shaft remains coupled to the engine external gearbox input shaft).

4. Engine Starter Control Valve

A. Description

The engine starter control valve (Ref. Fig. 5) is an electrically actuated, pneumatically operated butterfly valve. Pneumatic system air for engine starting is controlled by the starter control valve. A single valve is located on the right side of each engine, zones 412, 422, and 432.

Each starter control valve consists of an actuator mounted above a butterfly-type starter valve. A structural web connects the actuator to the valve body containing the butterfly disk. Mechanical linkage between the actuator and the starter valve consists of torque levers and a butterfly disk shaft. The shaft passes through the connecting web, and is mounted in Teflon-coated bushings at each end. An air bleed passage, consisting of drilled channels in the castings, permits pressurized air to flow from the upstream side of the starter valve to the dome of the actuator for operation of the double-acting piston/diaphragm.

The cast aluminum actuator is equipped with an indicator position switch, a solenoid-operated ball valve with a manual override control, and disk shaft operating linkage.

The 4.5-inch-diameter cylindrical starter valve contains a butterfly disk that pivots approximately 90 degrees on the disk shaft. The shaft is canted 13 degrees relative to the centerline of the cast stainless steel valve body. The steel butterfly disk incorporates stainless steel sealing rings to minimize air leakage.

Hexagonal fittings at the lower and upper ends of the disk shaft are provided for manual rotation of the disk. Butterfly disk positioning is indicated by a switch-controlled light on the ENGINE START panel and by embossed position letters on the top of the actuator housing. The end of th pin which fastens the shaft position indicator lever to the butterfly shaft will point either to the letter "O" (open) or letter "S" (shut) to indicate the position of the disk.

A replaceable filter element in the actuator body filters bleed air before it enters the solenoid-operated ball valve on its way to the actuator dome.

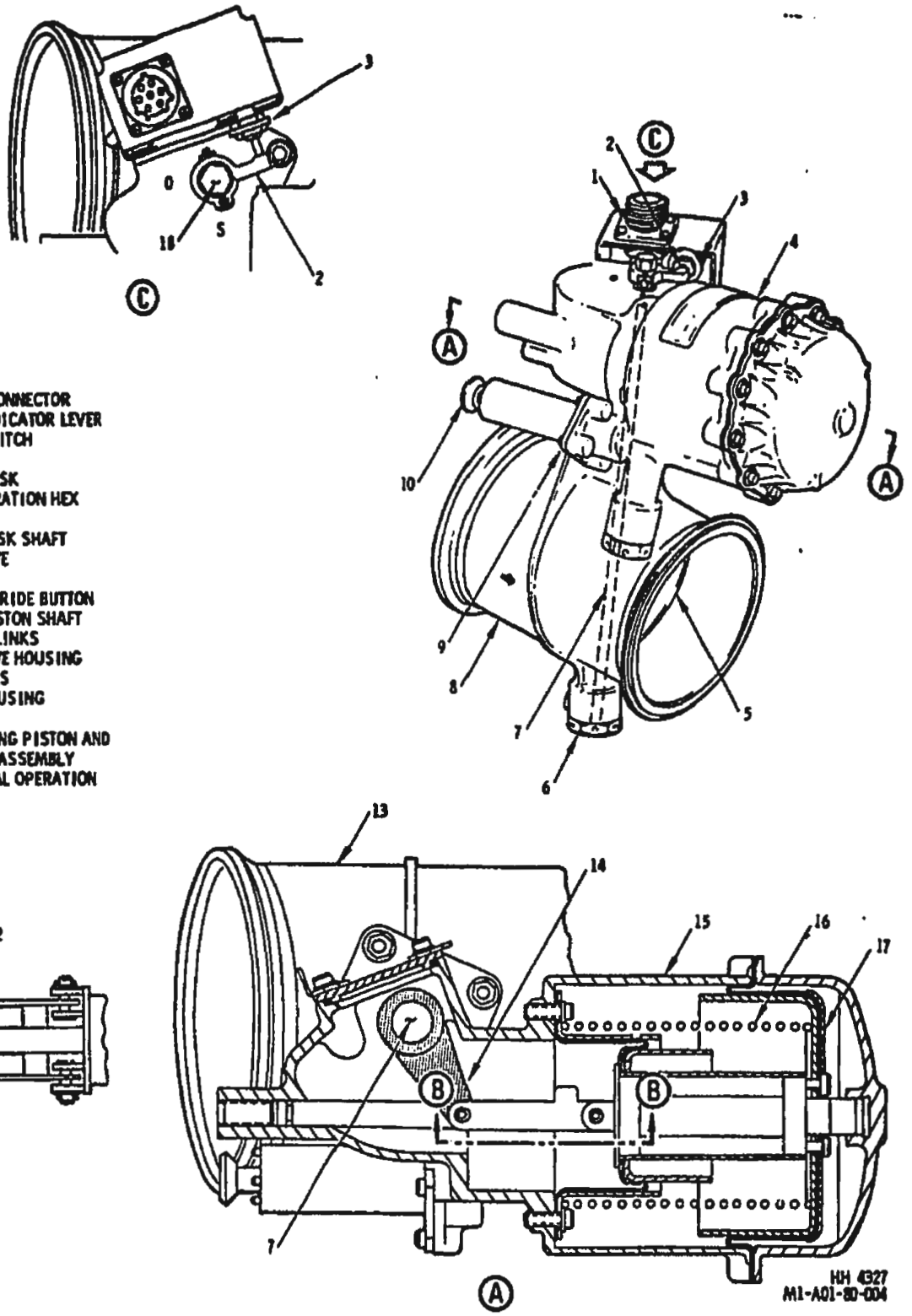
B. Operation

(1) General

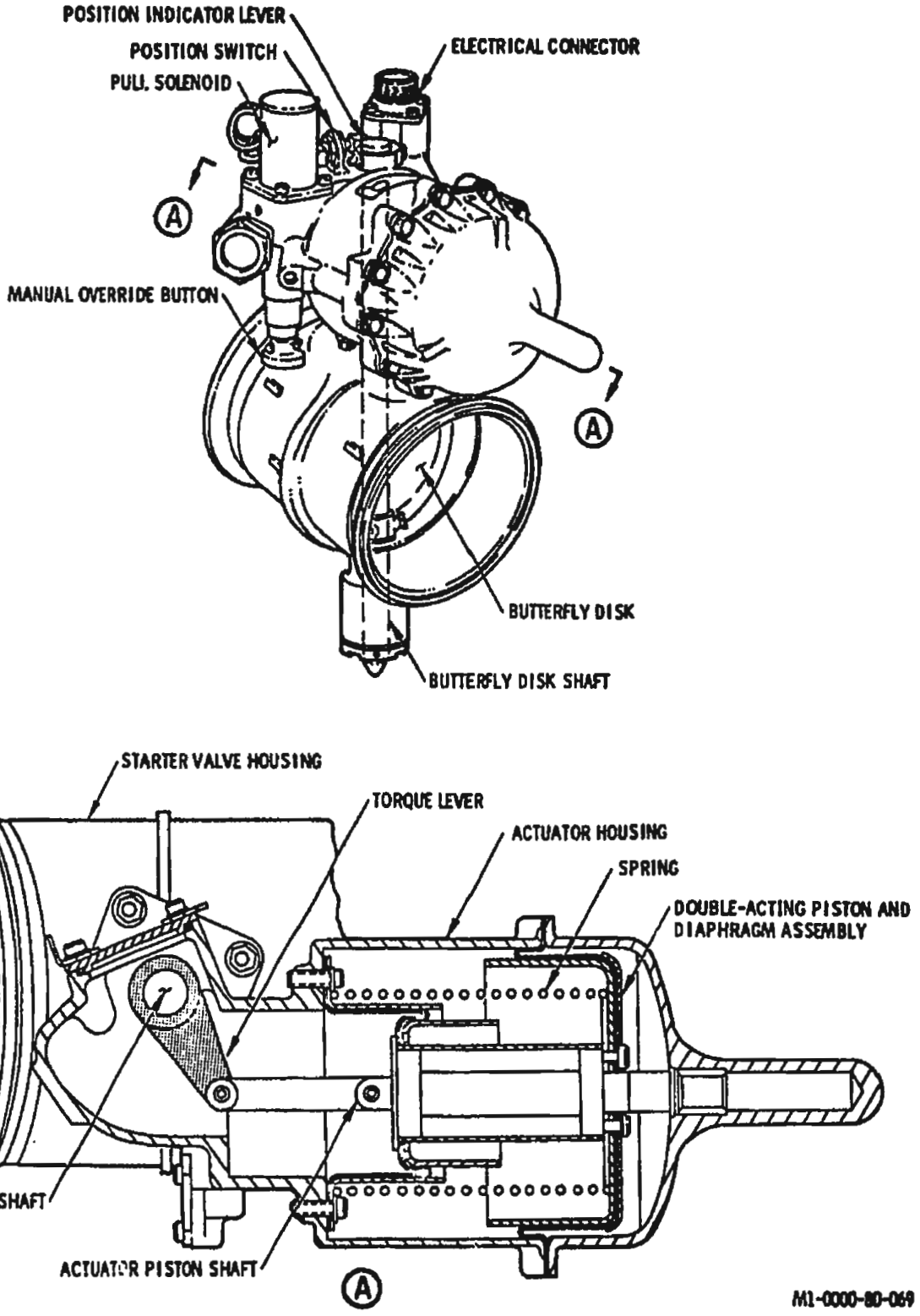
The actuator solenoid operates on 28V dc power. After electrical actuation, pneumatic (inlet air at a maximum pressure of 42 psig and a maximum temperature of 500 degrees F) and mechanical forces combine to operate the engine starter control valve (Ref. Fig. 6). Maximum valve opening time is 11.5 seconds. Maximum closing time is 2.0 seconds.

(2) To Open Valve

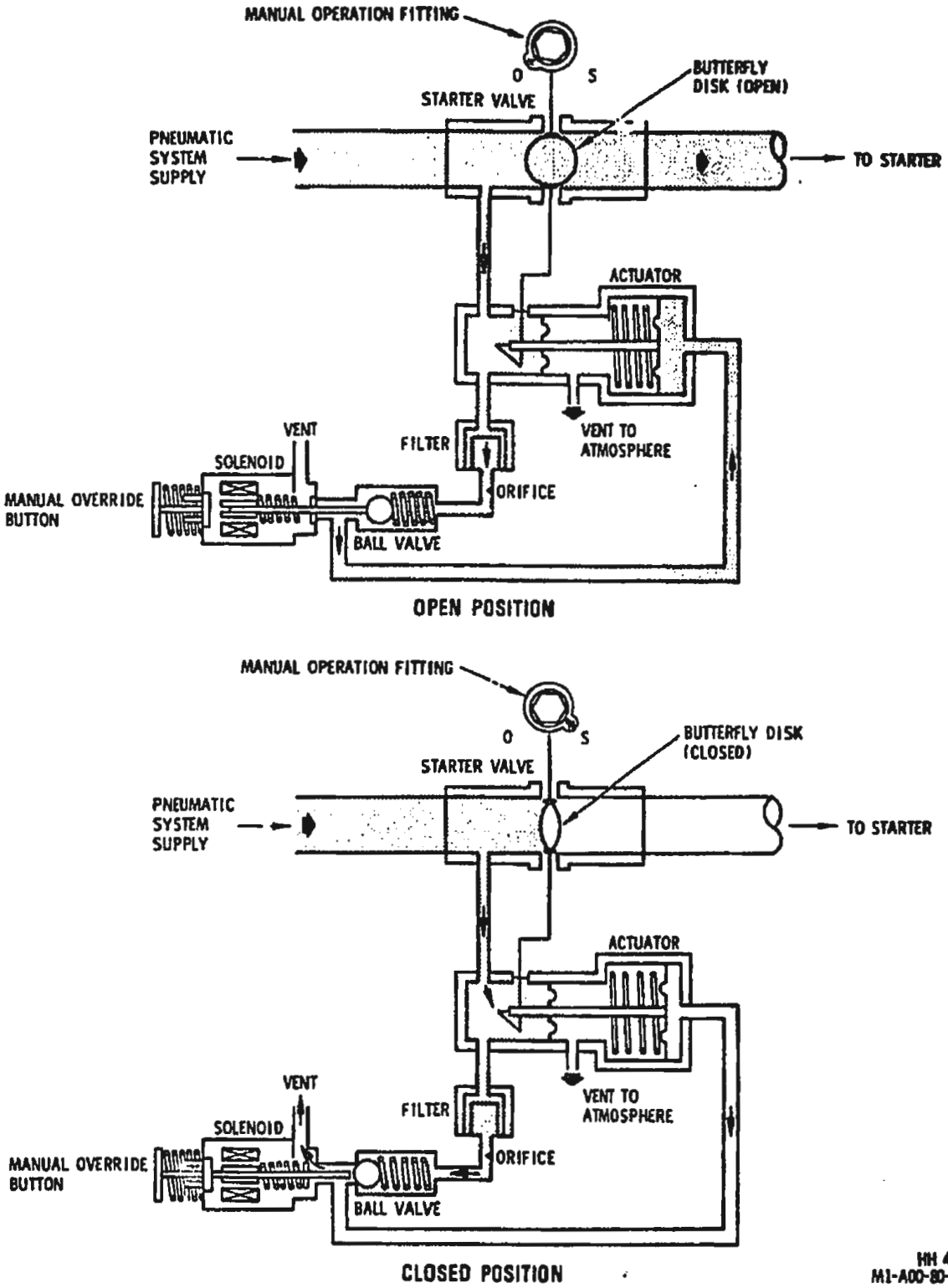
The normal starting procedure is initiated by depressing the applicable GROUND START switchlight on the pilots overhead ENGINE START panel, zone 210. This energizes the actuator solenoid which unseats the spring-loaded ball and simultaneously closes the solenoid vent port. Pneumatic system air in the starter duct upstream from the butterfly disk passes through a bleed passage, a filter, a fixed orifice, and past the unseated ball into the actuator chamber to act on the large surface of the double-acting piston and diaphragm assembly. As air pressure increases on this surface, the force overcomes the compression spring load and air pressure acting on the small surface of the piston and diaphragm. The resulting piston motion is translated through the connecting links and torque levers, rotating the butterfly disk to the open position. Movement of the starter valve shaft results



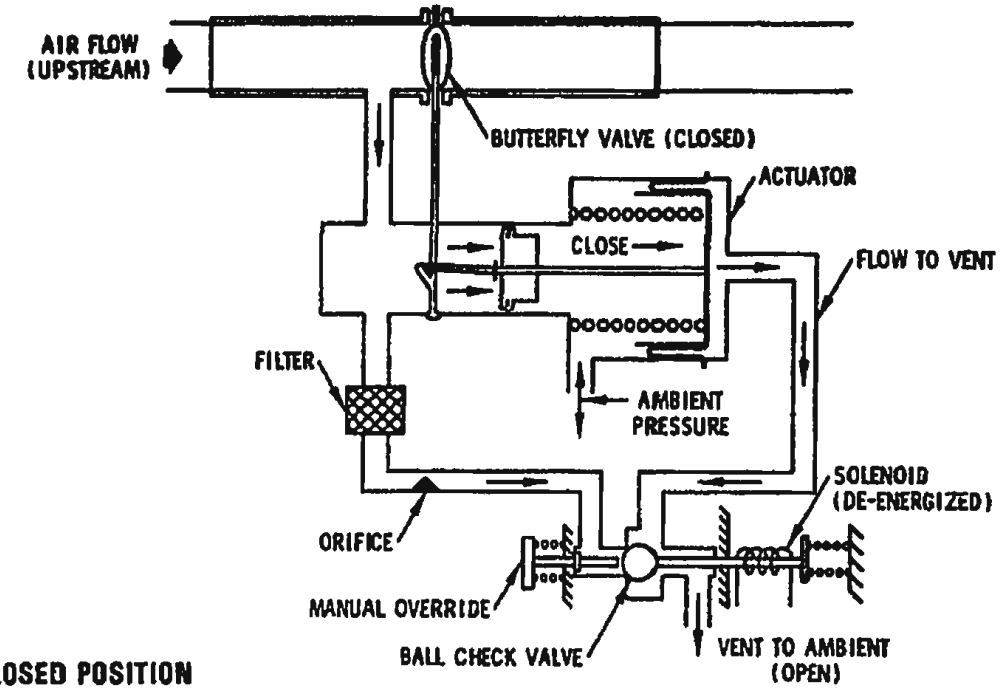
Pneumatic Starter Control Valve
Figure 5



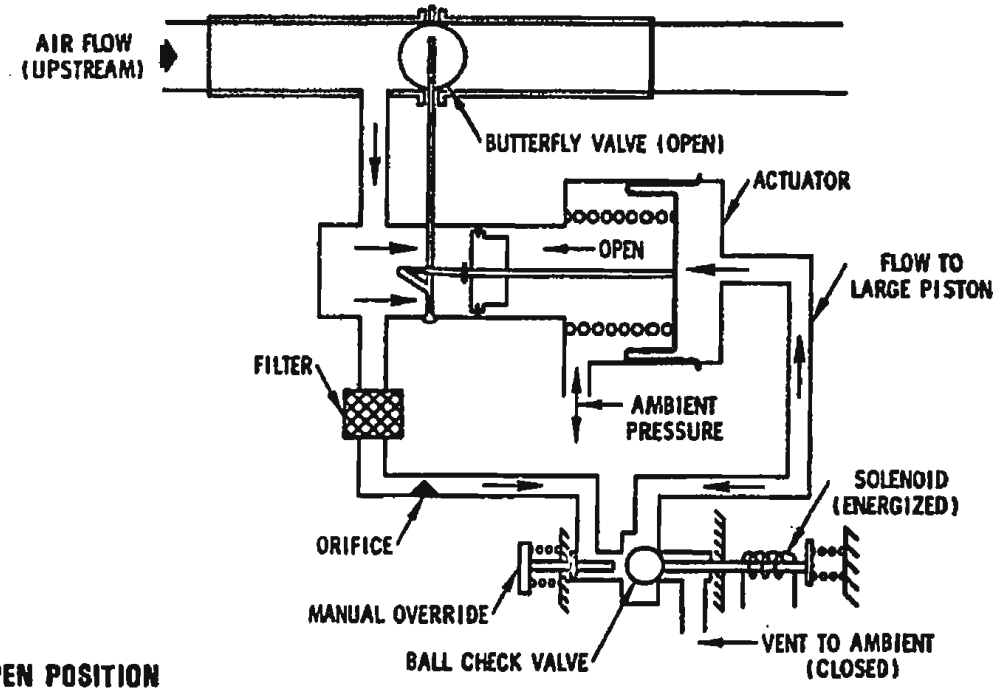
Pneumatic Starter Control Valve
Figure 5



Starter Control Valve Operating Schematic
Figure 6



CLOSED POSITION



OPEN POSITION

MI-0000-80-070

Starter Control Valve Operating Schematic
Figure 6

in similar movement of the indicator lever which, after 5 degrees of clockwise rotation, energizes the position indicator switch by releasing the plunger. The VALVE OPEN legend on the lens of the energized switchlight on the pilots ENGINE START panel is illuminated when the light comes on. The switchlight remains on as long as the butterfly disk is in the open position. The end of the pin which fastens the shaft position indicator lever to the butterfly shaft now points to the letter O embossed on the actuator housing.

(3) To Close Valve

The actuator solenoid is deenergized either by action of the N3 engine speed indicator internal switch, or by depressing the GND START RELEASE switchlight on the ENGINE START panel. Deenergizing the solenoid reseats the spring-loaded ball and opens the solenoid vent port to atmosphere. With the ball valve closed, airflow is cut off, and the actuator chamber depressurizes through the open solenoid vent. Upstream pneumatic system supply air acting on the small piston surface assists the compression spring in returning the double-acting piston and diaphragm assembly to the closed position. The actuator piston shaft, linkage, and torque levers move with the piston to rotate the butterfly disk to the closed position. As the butterfly disk closes, the position indicator lever rotates counterclockwise to depress the position indicator switch plunger. When the butterfly disk is 5 (±2) degrees from the closed position, the position switch opens and the VALVE OPEN light in the GROUND START off. With the butterfly disk closed, the end of the pin which fastens the shaft position indicator lever to the butterfly shaft now points to the letter S on the actuator housing.

(4) Fail-Safe Operation

Failure of either the double-acting piston and diaphragm assembly or the actuator compression spring will cause the butterfly disk to close the starter valve. If the spring fails, upstream air pressure works against the small area of the piston to close the valve. In the event of piston/diaphragm failure, the spring will move the piston to close the valve. Any loss of pneumatic pressure at the upstream side of the valve causes the valve to close through action of the spring against the actuator piston.

(5) Manual Operation

Two methods of ground operation are provided to cover abnormal conditions.

(a) A manual override button provides an emergency operation mode if there is an electrical malfunction of the actuator solenoid. Depressing the manual override button unseats the spring-loaded ball and closes the solenoid vent port. The starter control valve will function normally until the manual override button is released. Release of the override button results in the spring-loaded solenoid valve returning to the normal (extended) position. The ball valve closes under spring pressure to shut off airflow, and the vent valve opens to deplete air pressure in the actuator dome.

(b) If the butterfly disk does not rotate after the solenoid has been energized or after the manual override button has been depressed, the disk may be operated by using an appropriate tool to turn the hexagonal fitting on either the upper or lower end of the butterfly disk shaft.

R ENGINE STARTING SYSTEM - FAULT ISOLATION

R 1. General

R The fault isolation diagrams in this section can be used for fault isolation any time a fault is reported or suspected. Before fault isolation is started, the PREREQUISITES listed on the diagram must be fulfilled.

R If the flight crew reports a trouble using a FIRM Fault Code number, the number can be found in the FIRM Fault Code Cross Reference Table in the Chapter 80 INDEX.

R The FIRM Fault Code Cross Reference Table includes the flight report (fault symptoms) and the exact Section, Figure, Sheet, and Block number where fault isolation should begin. (Refer to the L-1011 Maintenance Manual Introduction for a more detailed explanation on the use of fault isolation diagrams.)

R If a fault is reported or suspected and no FIRM Fault Code is available, the function or fault indication can be found in the table below. When a diagram is selected in this manner fault isolation is started at Block 1.

R 2. Fault Isolation/Identification

R Table 101 is a list of all fault isolation data in this section of the manual.

R Fault Isolation Data
R Table 101

FIGURE	TITLE
101	Component Locator Index
102	Start System Component Locator
103	Starting Problems
SCHEM 1	Engine No. 1 Starting Circuits
SCHEM 2	Engine No. 2 Starting Circuits
SCHEM 3	Engine No. 3 Starting Circuits

COMPONENT	QTY	AREA/ACCESS	REFERENCE
N3 SHAFT SPEED INDICATOR	1	FLT STATION/PILOT CENTER INST. PANEL	77-12-08
STARTER CONTROL VALVE WING ENGINES	2	ACCESSORY SECTION/RH HINGED COWL	
NO. 2 ENGINE	1	ACCESSORY SECTION/LOWER RH HINGED COWL	80-11-08

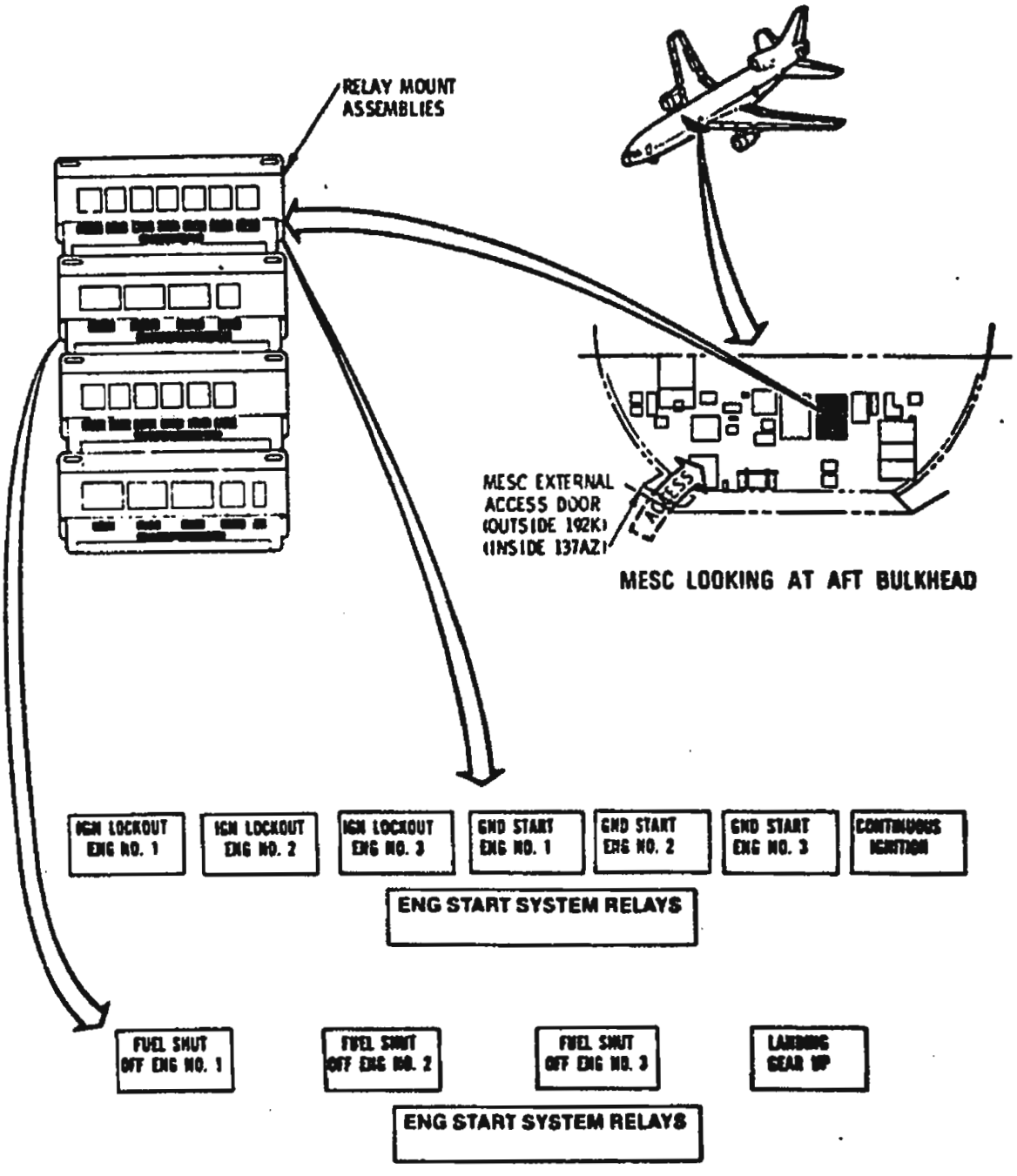
M1-0000-80-040

R
R

Component Locator Index
Figure 101

EFFECTIVITY: ALL

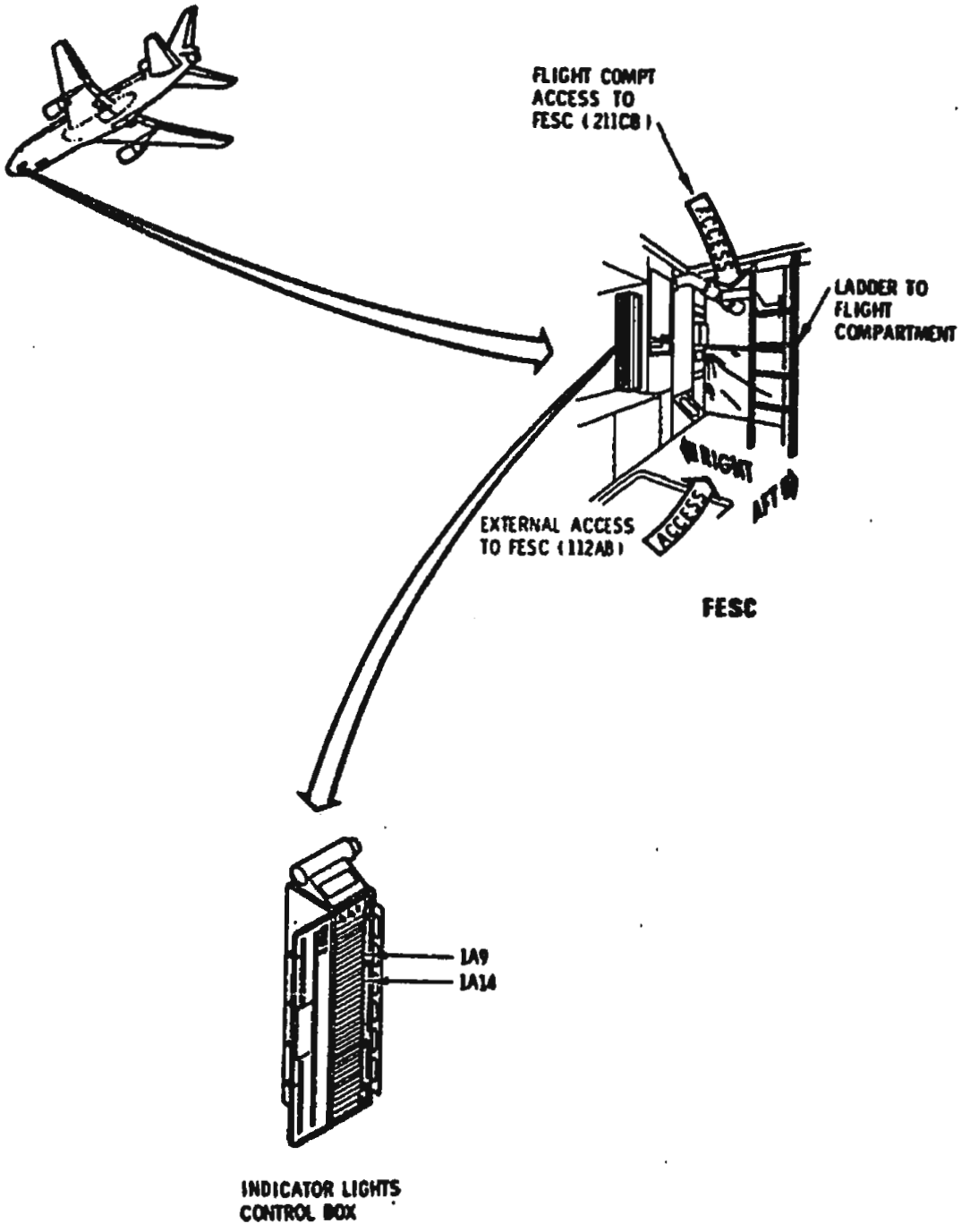
001B


RELAY MOUNT ASSEMBLIES
MESC EXTERNAL ACCESS DOOR (OUTSIDE 192K) (INSIDE 137AZ)
ACCESS
MESC LOOKING AT AFT BULKHEAD
IGN LOCKOUT ENG NO. 1
IGN LOCKOUT ENG NO. 2
IGN LOCKOUT ENG NO. 3
GND START ENG NO. 1
GND START ENG NO. 2
GND START ENG NO. 3
CONTINUOUS IGNITION
ENG START SYSTEM RELAYS
FUEL SHUT OFF ENG NO. 1
FUEL SHUT OFF ENG NO. 2
FUEL SHUT OFF ENG NO. 3
LANDING GEAR UP
ENG START SYSTEM RELAYS

M1-0100-74-022

R R Start System Component Locator
Figure 102 (Sheet 1)

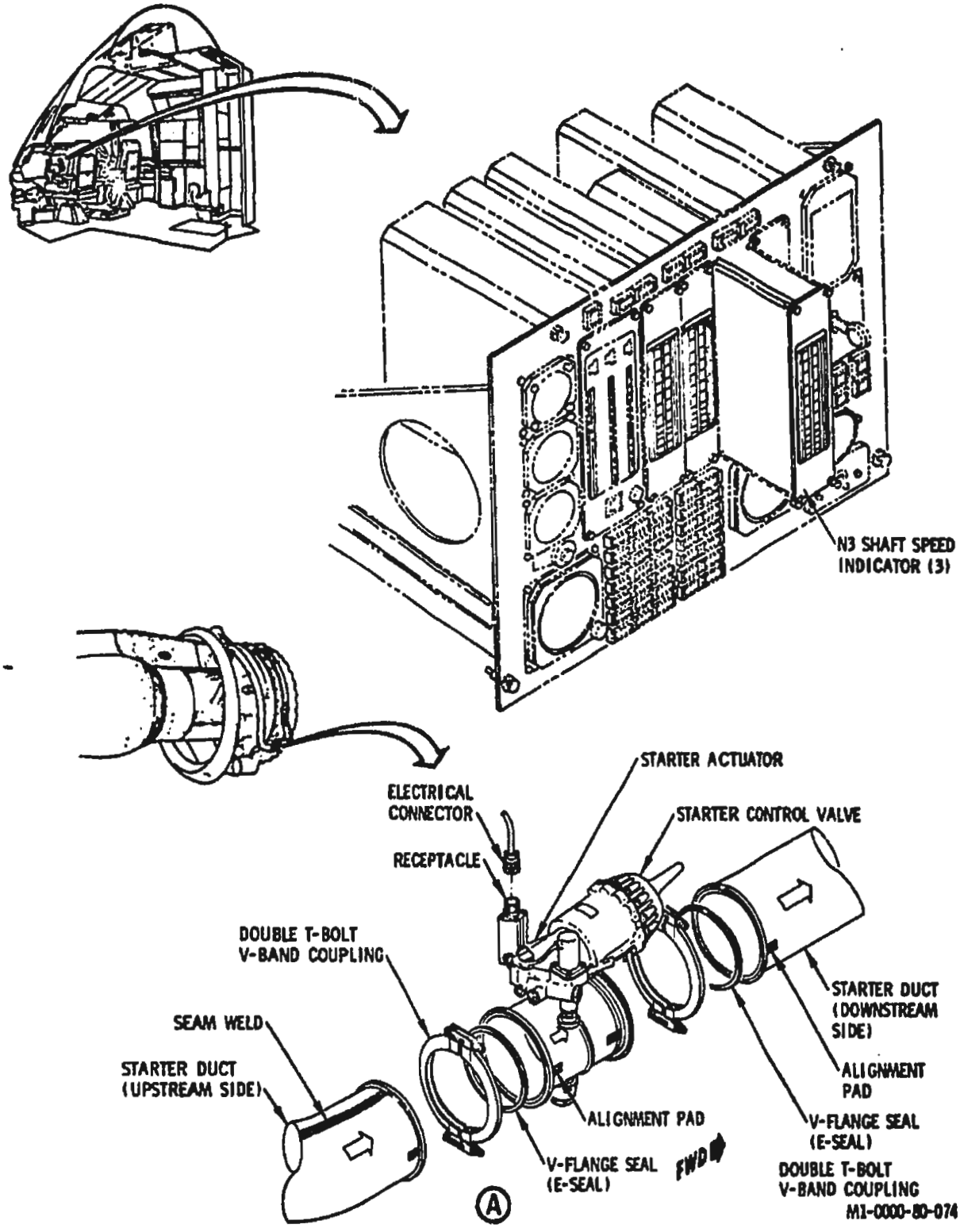
R R 001B EFFECTIVITY: ALL



AM-0808-74-025

R R Start System Component Locator
Figure 102 (Sheet 2)

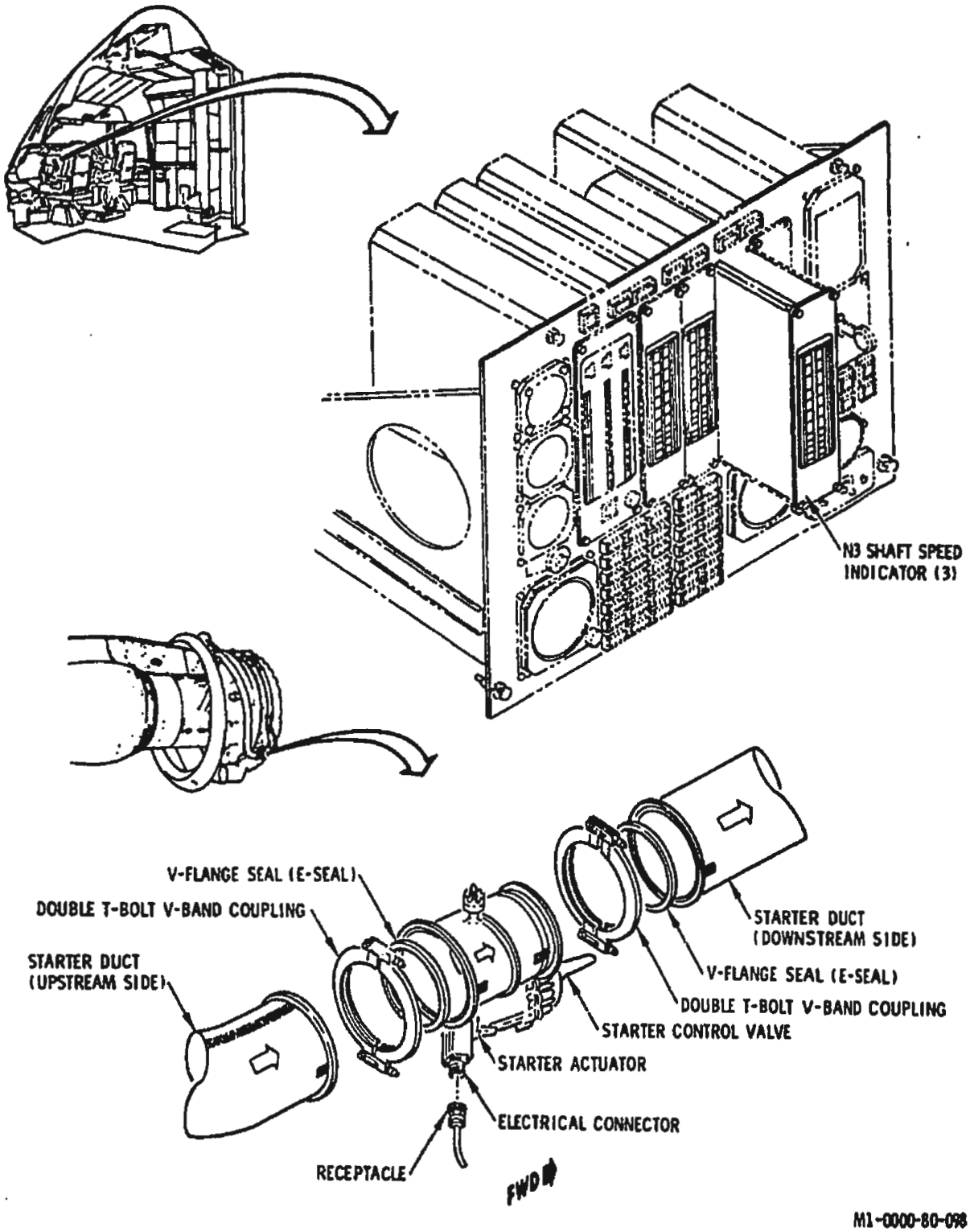
R R 001B EFFECTIVITY: ALL



R Start System Component Locator
R Figure 102 (Sheet 3)

EFFECTIVITY: WITH VALVE ACTUATOR FACING UP

001B

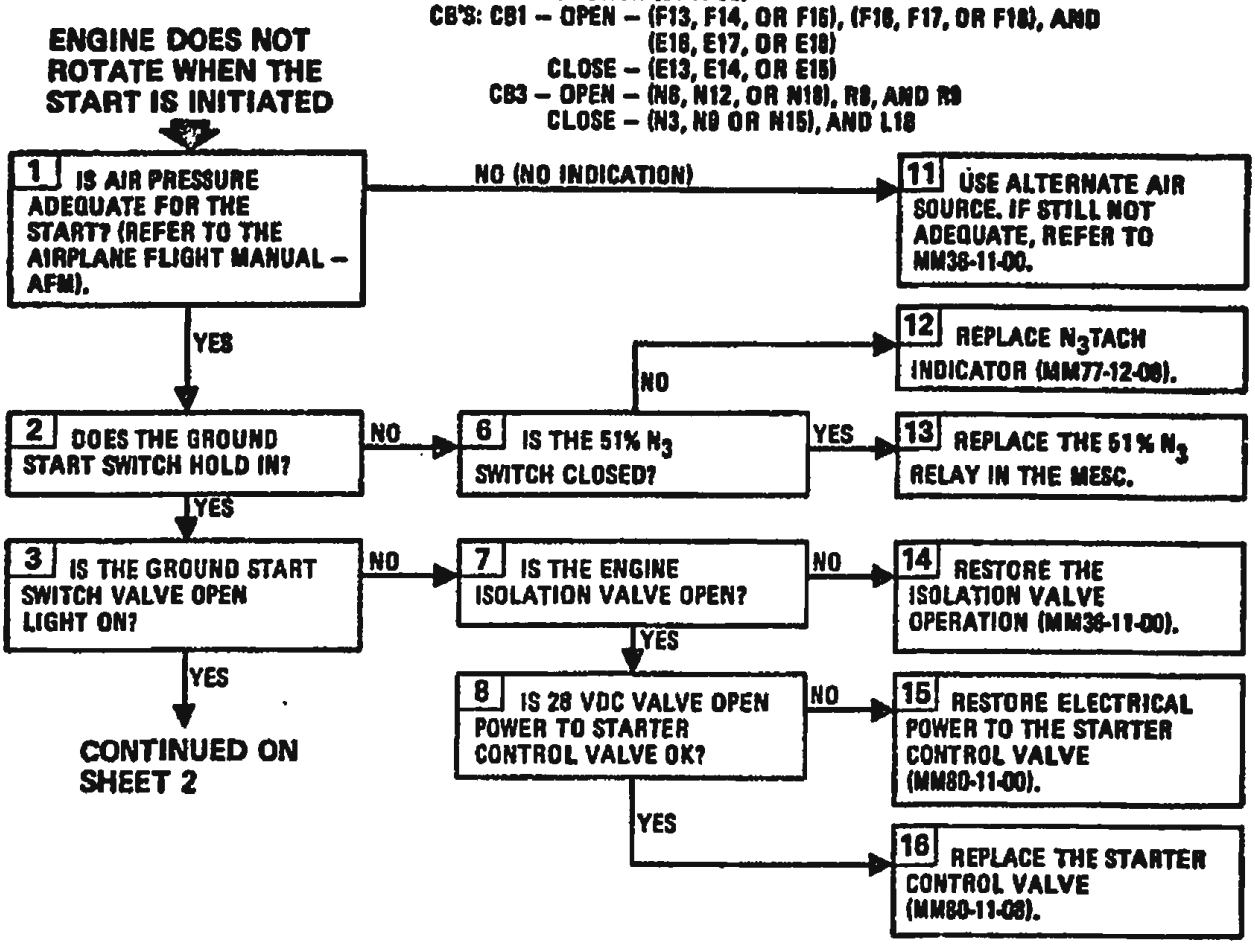


R R Start System Component Locator
Figure 102 (Sheet 3)

EFFECTIVITY: WITH VALVE ACTUATOR FACING DOWN

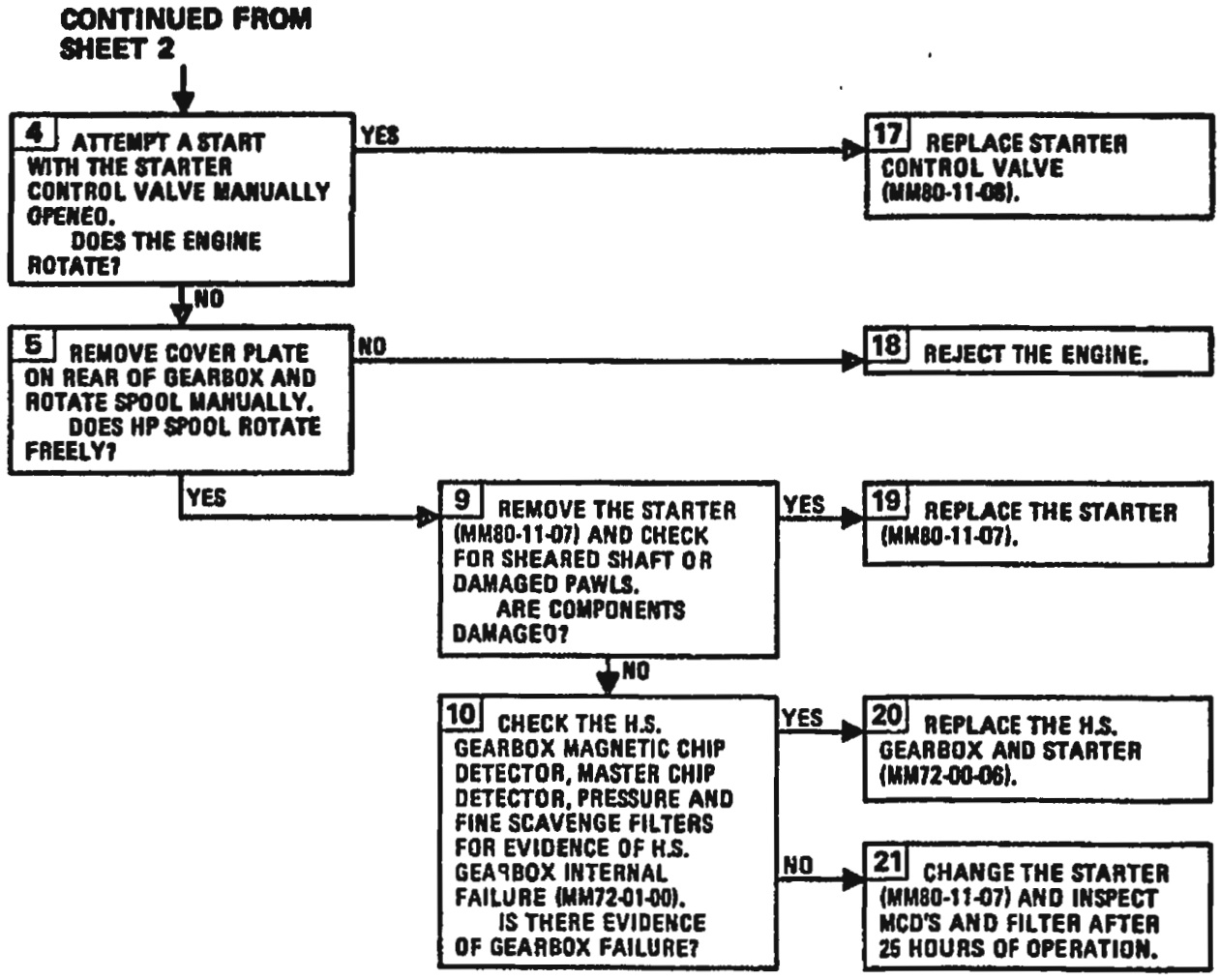
001B

PREREQUISITES
ELECTRICAL POWER (24-41-00)
CB'S: CB1 – OPEN – (F13, F14, OR F15), (F16, F17, OR F18), AND (E16, E17, OR E18)
CLOSE – (E13, E14, OR E15)
CB3 – OPEN – (N6, N12, OR N18), R8, AND R9
CLOSE – (N3, N9 OR N15), AND L18


ENGINE DOES NOT ROTATE WHEN THE START IS INITIATED
1 IS AIR PRESSURE ADEQUATE FOR THE START? (REFER TO THE AIRPLANE FLIGHT MANUAL – AFM).
NO (NO INDICATION)
11 USE ALTERNATE AIR SOURCE. IF STILL NOT ADEQUATE, REFER TO MM36-11-00.
YES
2 DOES THE GROUND START SWITCH HOLD IN?
NO
6 IS THE 51% N3 SWITCH CLOSED?
NO
12 REPLACE N3TACH INDICATOR (MM77-12-00).
YES
13 REPLACE THE 51% N3 RELAY IN THE MESC.
YES
3 IS THE GROUND START SWITCH VALVE OPEN LIGHT ON?
NO
7 IS THE ENGINE ISOLATION VALVE OPEN?
NO
14 RESTORE THE ISOLATION VALVE OPERATION (MM36-11-00).
YES
YES
CONTINUED ON SHEET 2
8 IS 28 VDC VALVE OPEN POWER TO STARTER CONTROL VALVE OK?
NO
15 RESTORE ELECTRICAL POWER TO THE STARTER CONTROL VALVE (MM80-11-00).
YES
16 REPLACE THE STARTER CONTROL VALVE (MM80-11-00).

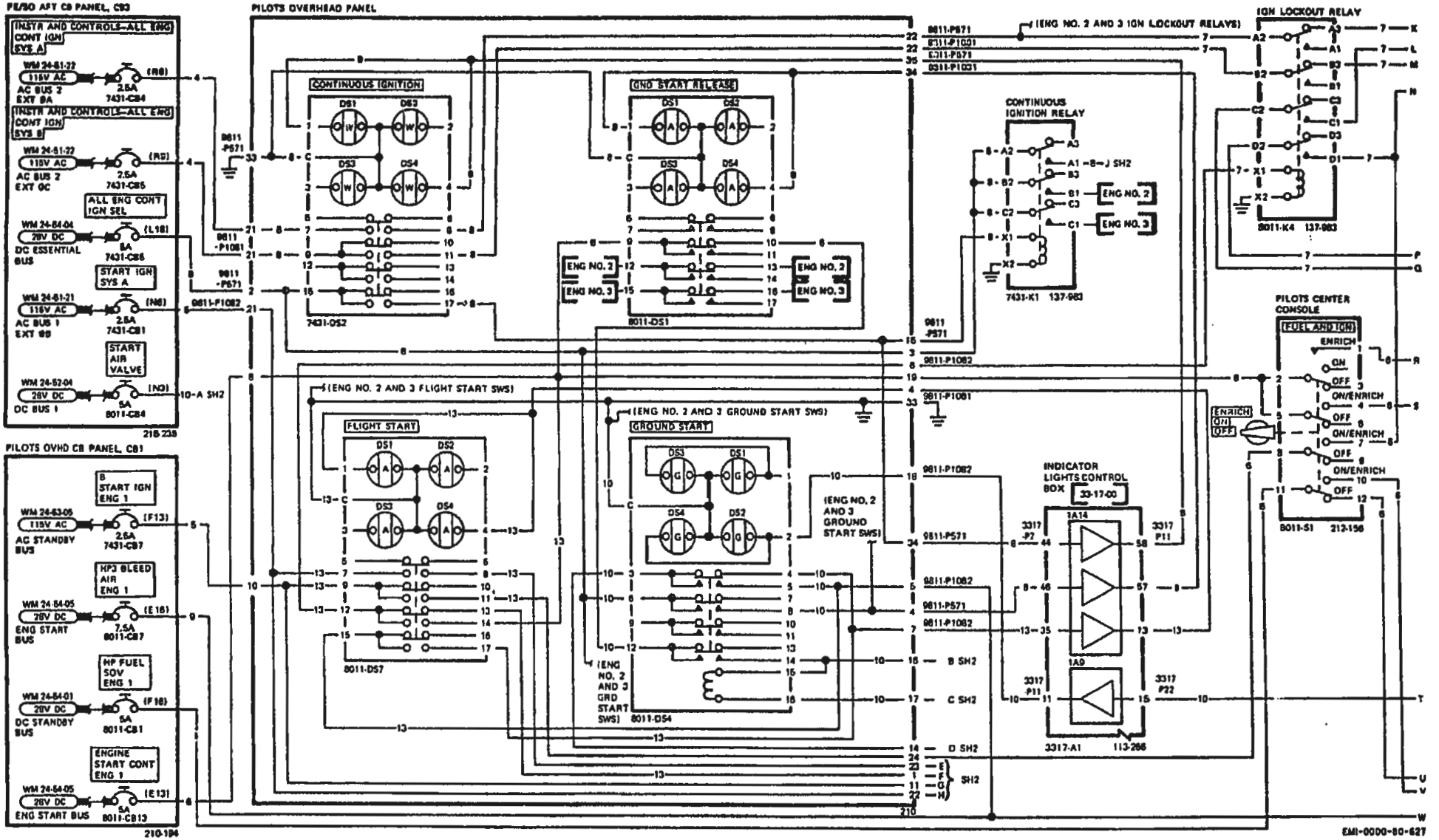
M1-0000-80-043

Starting Problems
Figure 103 (Sheet 1)


CONTINUED FROM SHEET 2
4 ATTEMPT A START WITH THE STARTER CONTROL VALVE MANUALLY OPENED. DOES THE ENGINE ROTATE?
YES
17 REPLACE STARTER CONTROL VALVE (MM80-11-08).
NO
5 REMOVE COVER PLATE ON REAR OF GEARBOX AND ROTATE SPOOL MANUALLY. DOES HP SPOOL ROTATE FREELY?
NO
18 REJECT THE ENGINE.
YES
9 REMOVE THE STARTER (MM80-11-07) AND CHECK FOR SHEARED SHAFT OR DAMAGED PAWLS. ARE COMPONENTS DAMAGED?
YES
19 REPLACE THE STARTER (MM80-11-07).
NO
10 CHECK THE H.S. GEARBOX MAGNETIC CHIP DETECTOR, MASTER CHIP DETECTOR, PRESSURE AND FINE SCAVENGE FILTERS FOR EVIDENCE OF H.S. GEARBOX INTERNAL FAILURE (MM72-01-00). IS THERE EVIDENCE OF GEARBOX FAILURE?
YES
20 REPLACE THE H.S. GEARBOX AND STARTER (MM72-00-06).
NO
21 CHANGE THE STARTER (MM80-11-07) AND INSPECT MCD'S AND FILTER AFTER 25 HOURS OF OPERATION.

M1-0000-80-044

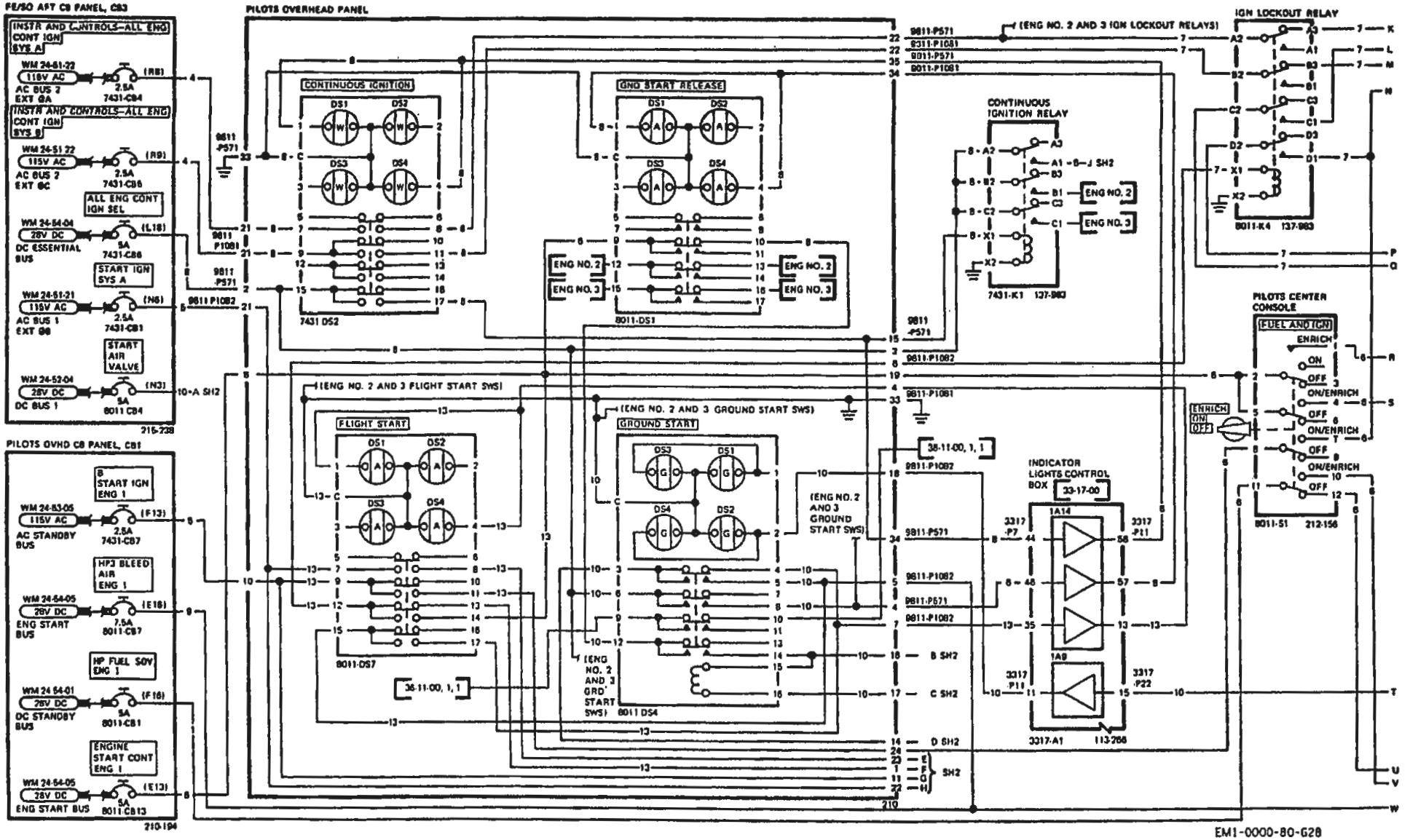
Starting Problems
Figure 103 (Sheet 2)



R Engine No. 1 Start Circuits
R SCHEM 1 (Sheet 1)

EFFECTIVITY: WITHOUT SB80-007

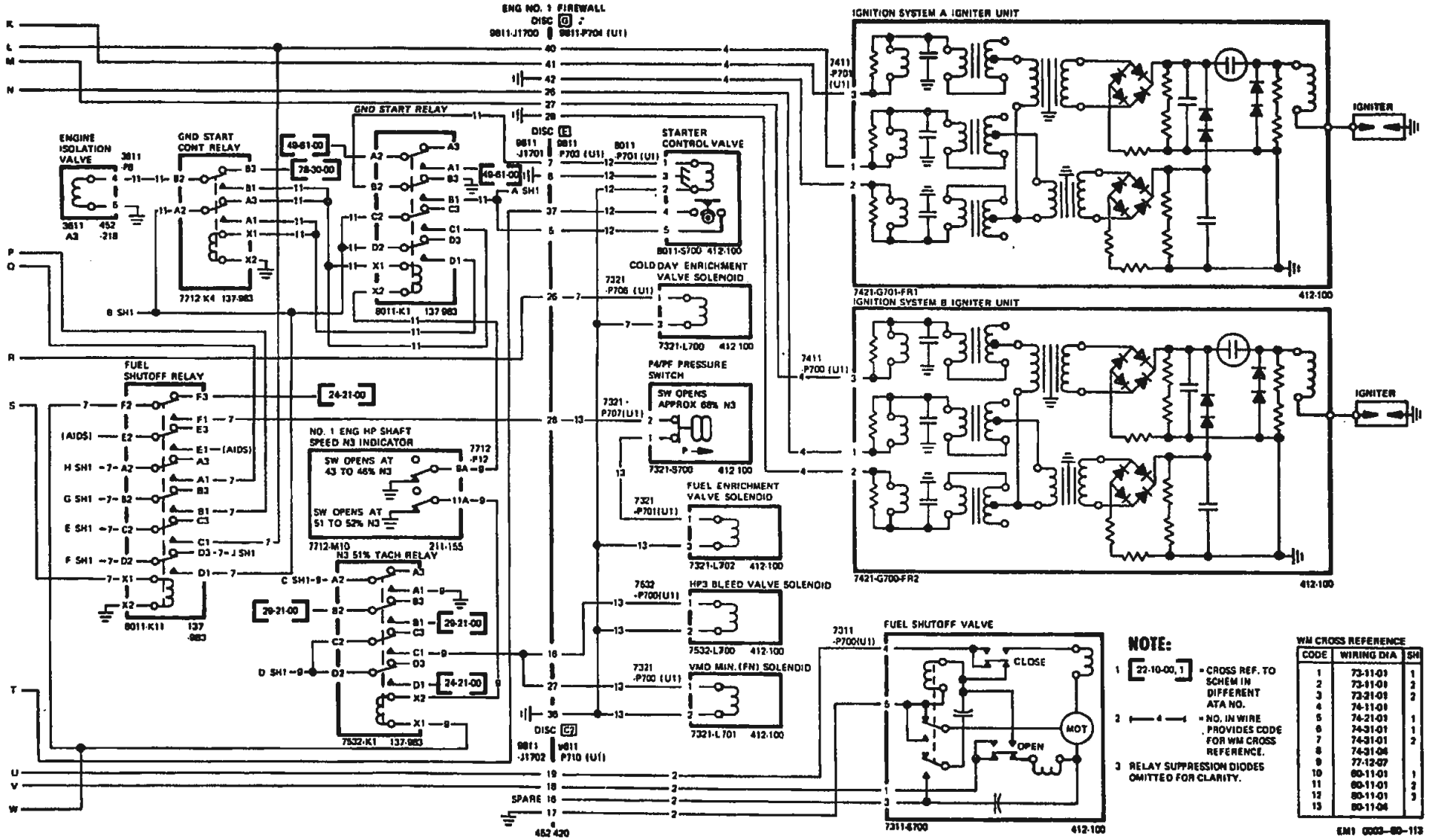
001B


FE/SO AFT CB PANEL, CB3
PILOTS OVERHEAD PANEL
IGN LOCKOUT RELAY
INSTR AND CONTROLS—ALL ENG CONT IGN SYS A
INSTR AND CONTROLS—ALL ENG CONT IGN SYS B
ALL ENG CONT IGN SEL
START IGN SYS A
START AIR VALVE
CONTINUOUS IGNITION
GND START RELEASE
CONTINUOUS IGNITION RELAY
(ENG NO. 2 AND 3 IGN LOCKOUT RELAYS)
PILOTS CENTER CONSOLE
FUEL AND IGN
ENRICH
(ENG NO. 2 AND 3 FLIGHT START SWS)
(ENG NO. 2 AND 3 GROUND START SWS)
FLIGHT START
GROUND START
INDICATOR LIGHTS CONTROL BOX 33-17-00
PILOTS OVHD CB PANEL, CB1
B START IGN ENG 1
HP3 BLEED AIR ENG 1
HP FUEL SOV ENG 1
ENGINE START CONT ENG 1
EM1-0000-80-G28

Engine No. 1 Start Circuits
SCHEM 1 (Sheet 1)

EFFECTIVITY: WITH SB80-007

001B



NOTE:

1 [22-10-00, 1] = CROSS REF. TO SCHEM IN DIFFERENT ATA NO.

2 —4— = NO. IN WIRE . PROVIDES CODE FOR WM CROSS REFERENCE.

3 RELAY SUPPRESSION DIODES OMITTED FOR CLARITY.

WM CROSS REFERENCE

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1	73-11-01	1
2	73-11-01	2
3	73-21-01	2
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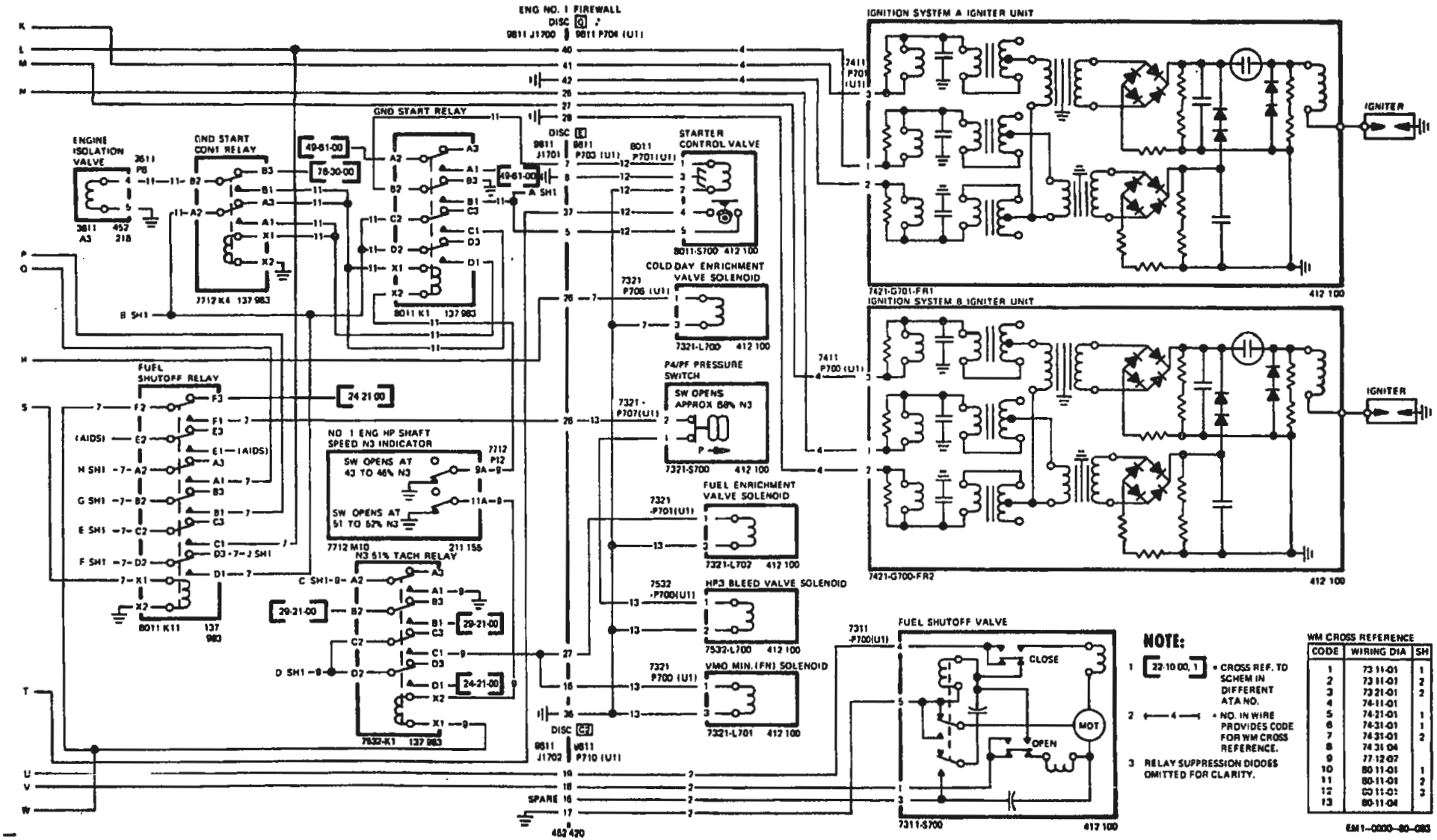
5	74-21-01	1
6	74-31-01	1
7	74-31-01	2
8	74-31-04	
9	77-12-07	
10	80-11-01	1
11	80-11-01	2
12	80-11-01	3
13	80-11-04	

EM1 0003-80-113

Engine No. 1 Start Circuits
SCHEM 1 (Sheet 2)

RR 0018 EFFECTIVITY: ENGINES WITHOUT RR SB71-5474



NOTE:

1 [22-10-00, 1] • CROSS REF. TO SCHEM IN DIFFERENT ATA NO.

2 ⟵4⟶ • NO. IN WIRE PROVIDES CODE FOR WM CROSS REFERENCE.

3 RELAY SUPPRESSION DIODES OMITTED FOR CLARITY.

WM CROSS REFERENCE

CODE	WIRING DIA	SH
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2	73-11-01	2
3	73-21-01	2
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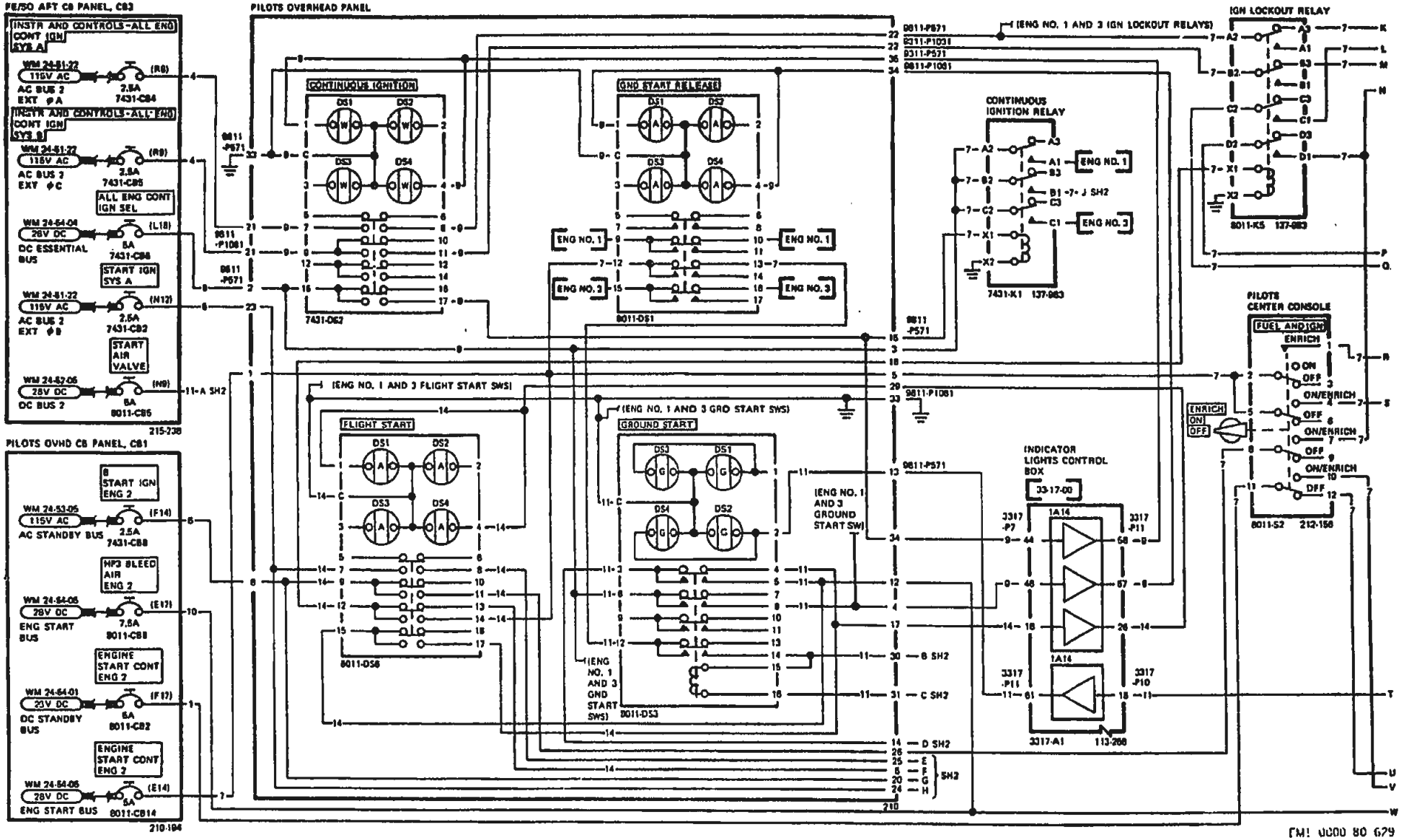
7	74-31-01	2
8	74-31-04	
9	77-12-07	
10	80-11-01	1
11	80-11-01	2
12	80-11-01	3
13	80-11-04	

6M1-0000-80-083

Engine No. 1 Start Circuits
SCHEM 1 (Sheet 2)

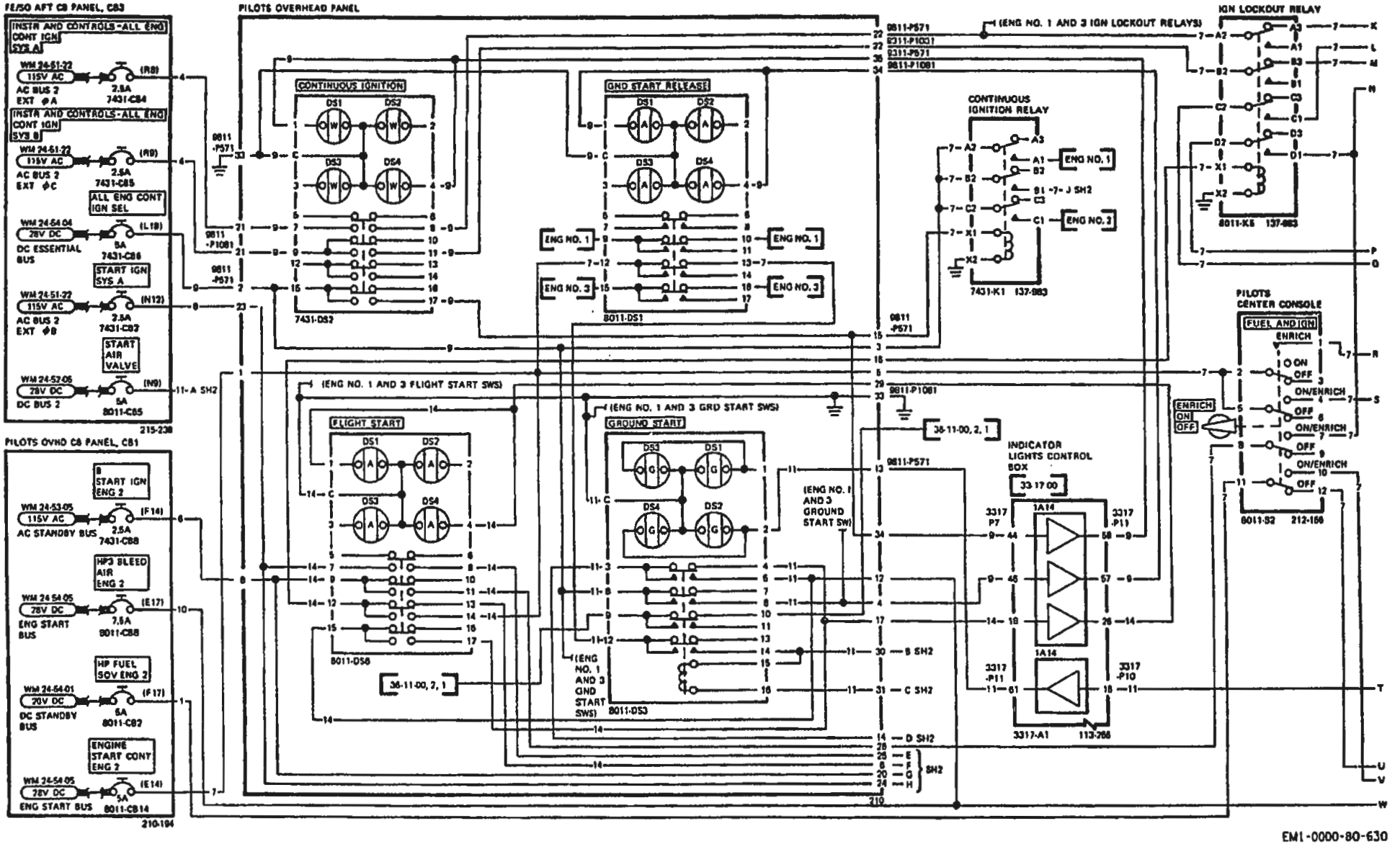
R EFFECTIVITY: ENGINES WITH RR SB71-5474
R
001B



R Engine No. 2 Start Circuits
R SCHEM 2 (Sheet 1)

EFFECTIVITY: WITHOUT SB80-007

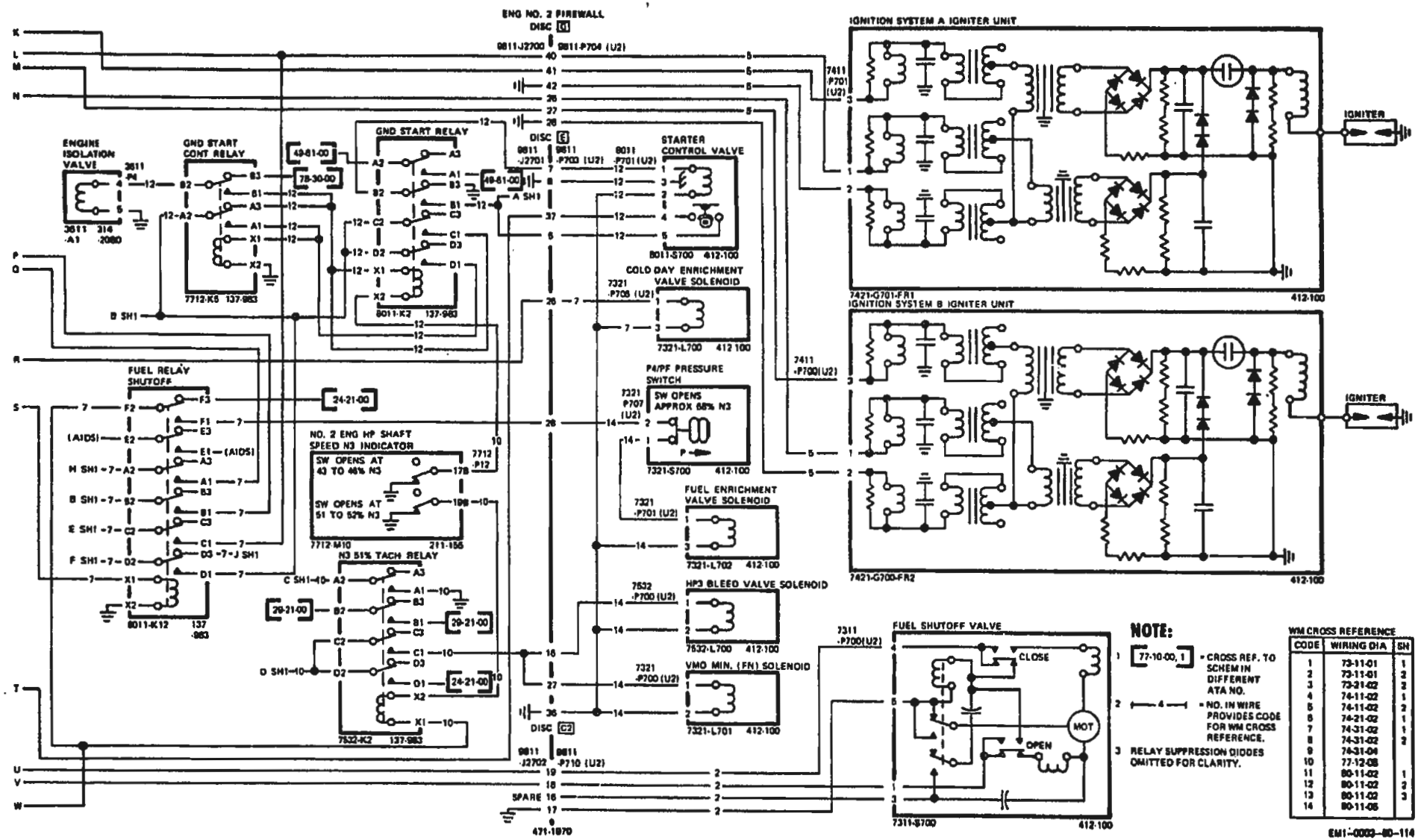
001B


FE/SO AFT CB PANEL, CB3
PILOTS OVERHEAD PANEL
IGN LOCKOUT RELAY
CONTINUOUS IGNITION
GND START RELEASE
CONTINUOUS IGNITION RELAY
PILOTS CENTER CONSOLE
FUEL AND IGN
ENRICH
PILOTS OVHD CB PANEL, CB1
FLIGHT START
GROUND START
INDICATOR LIGHTS CONTROL BOX
(ENG NO. 1 AND 3 IGN LOCKOUT RELAYS)
(ENG NO. 1 AND 3 FLIGHT START SWS)
(ENG NO. 1 AND 3 GRD START SWS)
(ENG NO. 1 AND 3 GND START SWS)
INSTR AND CONTROLS-ALL ENG CONT IGN SYS A
INSTR AND CONTROLS-ALL ENG CONT IGN SYS B
ALL ENG CONT IGN SEL
START IGN SYS A
START AIR VALVE
B START IGN ENG 2
HP3 BLEED AIR ENG 2
HP FUEL SOV ENG 2
ENGINE START CONT ENG 2
AC BUS 2 EXT φA
AC BUS 2 EXT φC
DC ESSENTIAL BUS
AC BUS 2 EXT φB
DC BUS 2
AC STANDBY BUS
ENG START BUS
DC STANDBY BUS
ENG NO. 1
ENG NO. 3
ON
OFF
ON/ENRICH
EMI-0000-80-630

R Engine No. 2 Start Circuits
R SCHEM 2 (Sheet 1)

EFFECTIVITY: WITH SB80-007

001B


ENG NO. 2 FIREWALL
DISC K1
IGNITION SYSTEM A IGNITER UNIT
IGNITION SYSTEM B IGNITER UNIT
IGNITER
ENGINE ISOLATION VALVE
GND START CONT RELAY
GND START RELAY
STARTER CONTROL VALVE
COLD DAY ENRICHMENT VALVE SOLENOID
P4/P3 PRESSURE SWITCH
SW OPENS APPROX 68% N3
FUEL ENRICHMENT VALVE SOLENOID
HP3 BLEED VALVE SOLENOID
VMO MIN. (FN) SOLENOID
FUEL RELAY SHUTOFF
NO. 2 ENG HP SHAFT SPEED N3 INDICATOR
SW OPENS AT 43 TO 46% N3
SW OPENS AT 51 TO 52% N3
N3 51% TACH RELAY
FUEL SHUTOFF VALVE
CLOSE
OPEN
MOT
DISC C2
SPARE 16
NOTE:
1 77-10-00, 1 = CROSS REF. TO SCHEM IN DIFFERENT ATA NO.
2 = NO. IN WIRE PROVIDES CODE FOR WM CROSS REFERENCE.
3 RELAY SUPPRESSION DIODES OMITTED FOR CLARITY.
WM CROSS REFERENCE
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3 | 73-21-02 | 2
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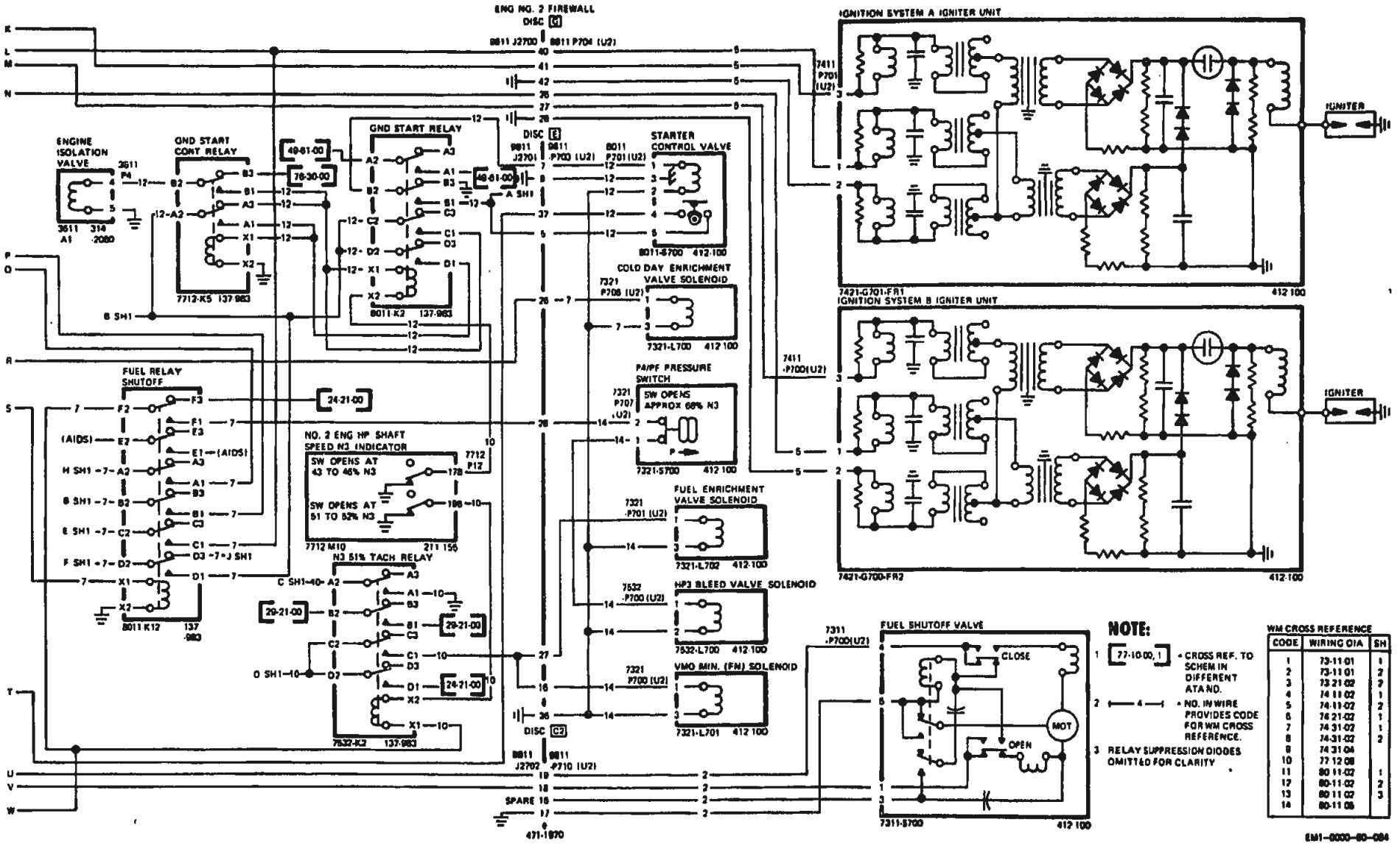
6 | 74-21-02 | 1
7 | 74-31-02 | 1
8 | 74-31-02 | 2
9 | 74-31-04
10 | 77-12-08
11 | 80-11-02 | 1
12 | 80-11-02 | 2
13 | 80-11-02 | 3
14 | 80-11-05
EM1-0003-80-114

Engine No. 2 Start Circuits
SCHEM 2 (Sheet 2)

R EFFECTIVITY: ENGINES WITHOUT RR SB71-5474
R
001B



NOTE:

1 [77-10-00, 1] * CROSS REF. TO SCHEM IN DIFFERENT ATA NO.

2 * NO. IN WIRE PROVIDES CODE FOR WM CROSS REFERENCE.

3 RELAY SUPPRESSION DIODES OMITTED FOR CLARITY

WM CROSS REFERENCE

CODE	WIRING DIA	SH
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2	73-11-01	2
3	73-21-02	2
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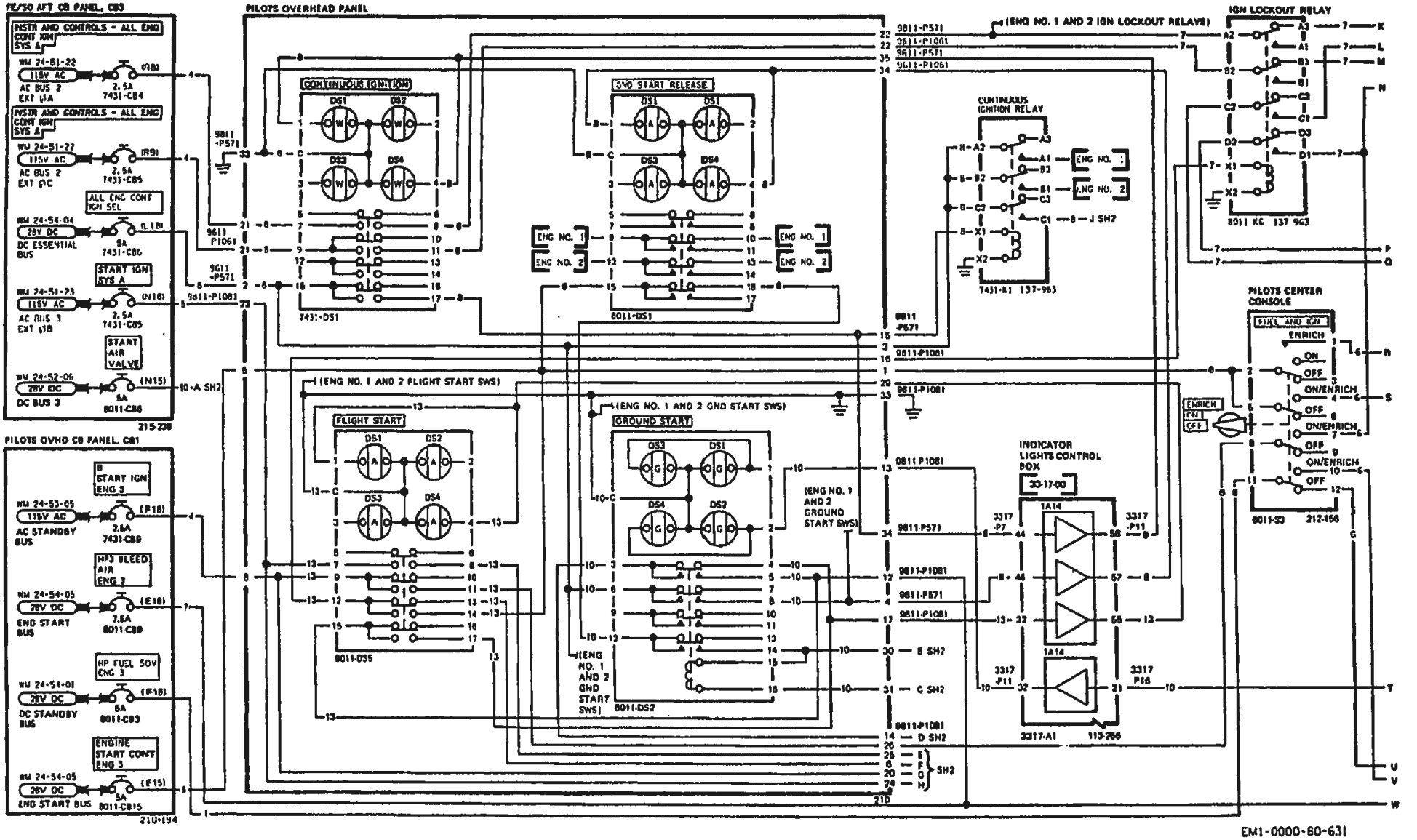
6	74-21-02	1
7	74-31-02	1
8	74-31-02	2
9	74-31-04	
10	77-12-08	
11	80-11-02	1
12	80-11-02	2
13	80-11-02	3
14	80-11-06	

EM1-0000-80-084

Engine No. 2 Start Circuits
SCHEM 2 (Sheet 2)

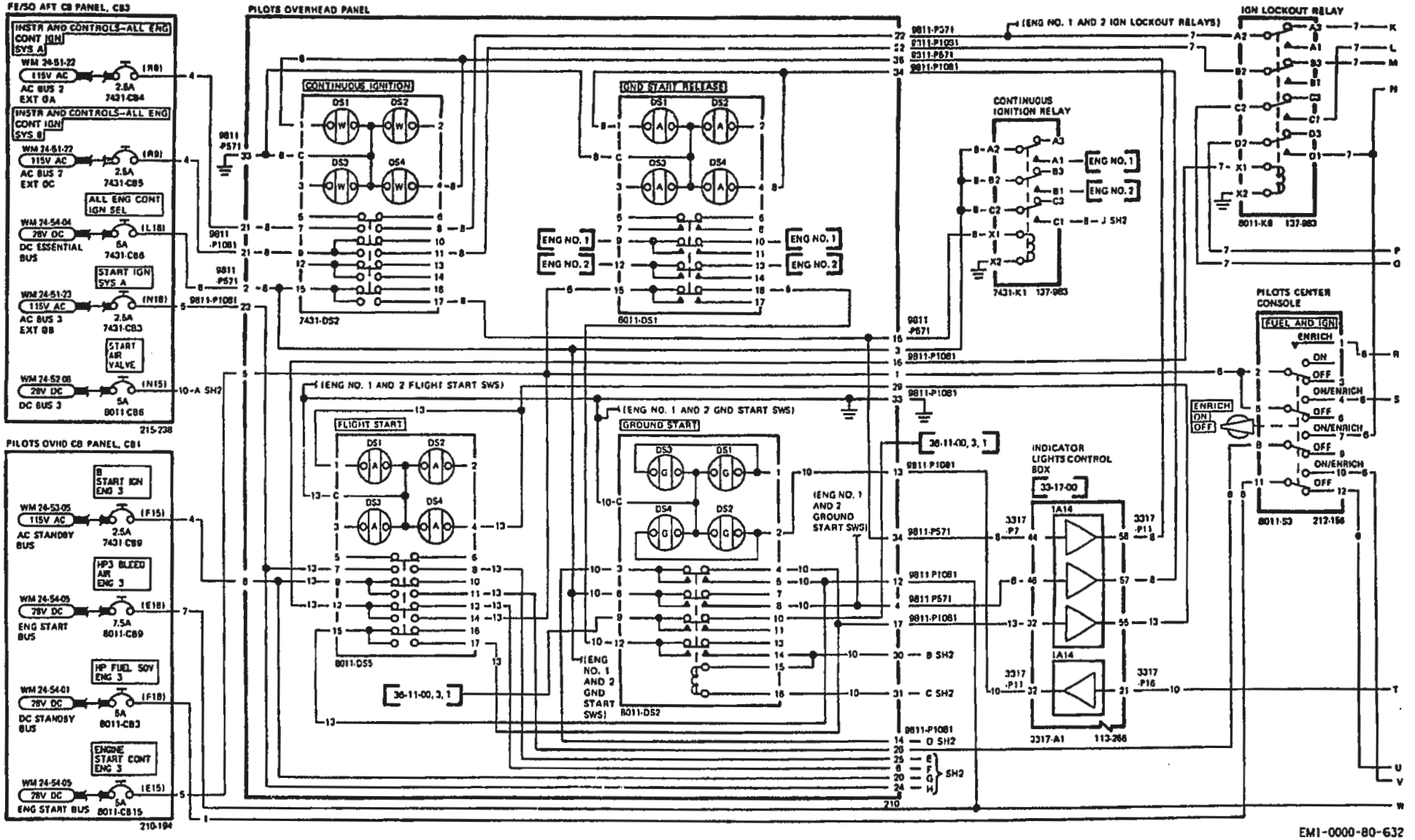
R EFFECTIVITY: ENGINES WITH RR SB71-5474
R
001B



Engine No. 3 Start Circuits
SCHEM 3 (Sheet 1)

EFFECTIVITY: WITHOUT SB80-007

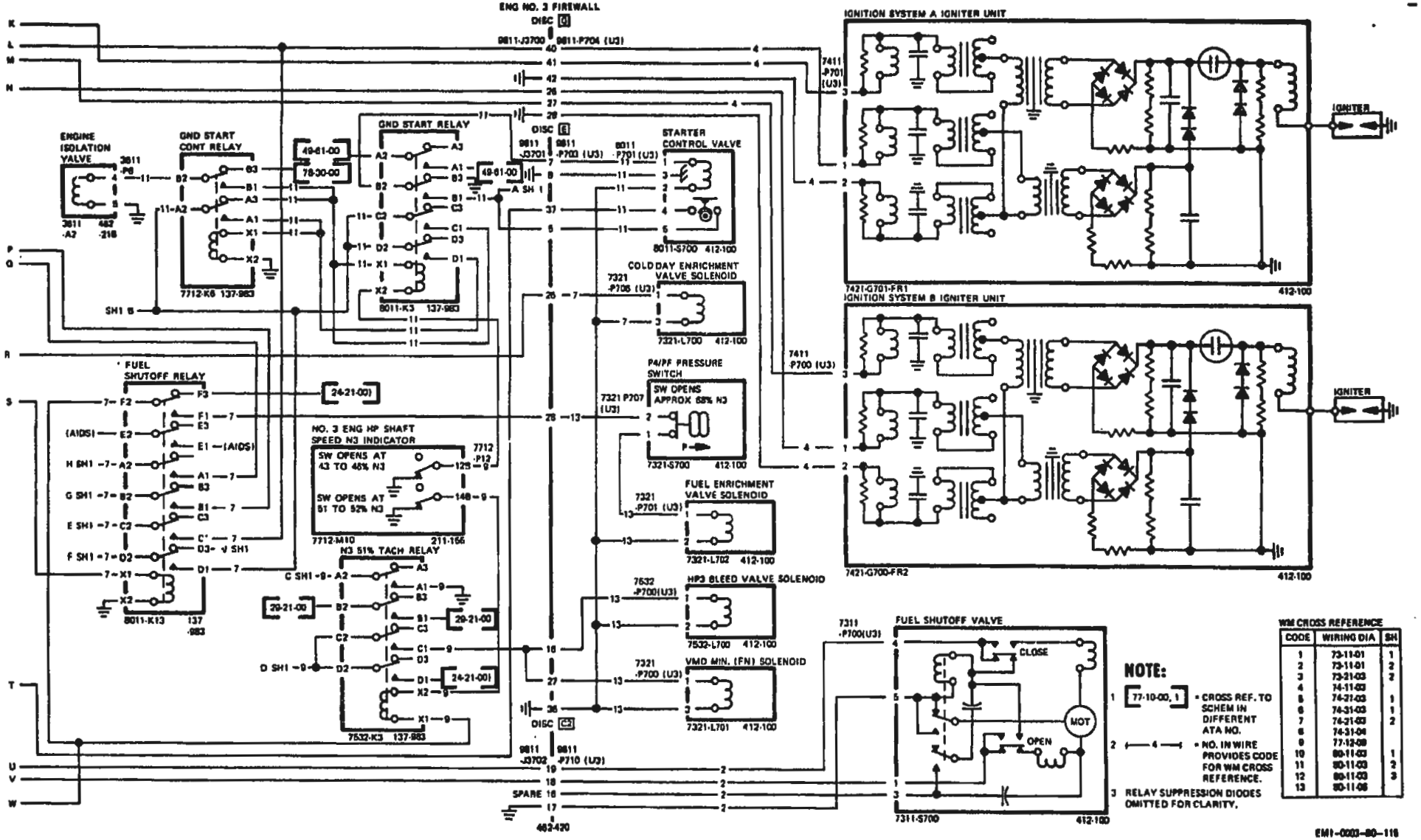
001B



Engine No. 3 Start Circuits
SCHEM 3 (Sheet 1)

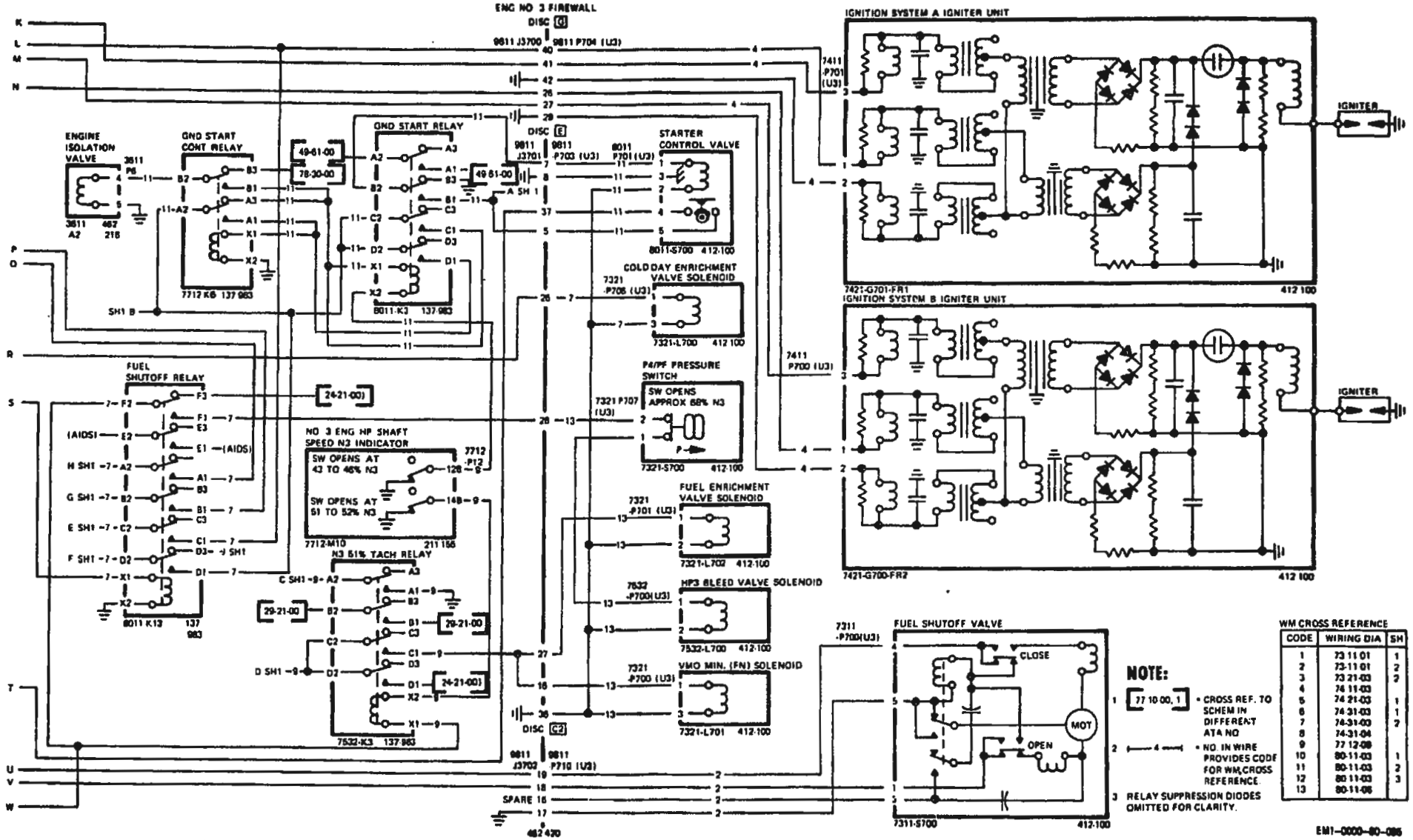
EFFECTIVITY: WITH SB80-007

001B



Engine No. 3 Start Circuits
SCHEM 3 (Sheet 2)

R EFFECTIVITY: ENGINES WITHOUT RR SB71-5474
R
001B


ENG NO 3 FIREWALL
IGNITION SYSTEM A IGNITER UNIT
IGNITION SYSTEM B IGNITER UNIT
IGNITER
ENGINE ISOLATION VALVE
GND START CONT RELAY
GND START RELAY
STARTER CONTROL VALVE
COLD DAY ENRICHMENT VALVE SOLENOID
P4/PF PRESSURE SWITCH
SW OPENS APPROX 68% N3
FUEL SHUTOFF RELAY
NO 3 ENG HP SHAFT SPEED N3 INDICATOR
SW OPENS AT 43 TO 46% N3
SW OPENS AT 51 TO 52% N3
N3 51% TACH RELAY
FUEL ENRICHMENT VALVE SOLENOID
HP3 BLEED VALVE SOLENOID
VMO MIN. (FN) SOLENOID
FUEL SHUTOFF VALVE
CLOSE
OPEN
MOT
SPARE 16
SPARE 17
NOTE:
1 CROSS REF. TO SCHEM IN DIFFERENT ATA NO
2 NO. IN WIRE PROVIDES CODE FOR WM CROSS REFERENCE.
3 RELAY SUPPRESSION DIODES OMITTED FOR CLARITY.
WM CROSS REFERENCE
CODE | WIRING DIA | SH
1 | 73 11 01 | 1
2 | 73 11 01 | 2
3 | 73 21 03 | 2
4 | 74 11 03
5 | 74 21 03 | 1
6 | 74 31 03 | 1
7 | 74 31 00 | 2
8 | 74 31 04
9 | 77 12 00
10 | 80 11 03 | 1
11 | 80 11 03 | 2
12 | 80 11 03 | 3
13 | 80 11 06
EM1-0000-80-086

Engine No. 3 Start Circuits
SCHEM 3 (Sheet 2)

R
R
001B

EFFECTIVITY: ENGINES WITH RR SB71-5474

GROUND START SWITCHLIGHT MAINTENANCE PRACTICES

1. General

R This procedure verifies that, with an inoperative GROUND START
R switchlight VALVE OPEN indication, the switchlight releases at
R 51% N3 and the starter control valve closes after engine start.

2. Referenced Procedures

71-11-00 Engines No. 1 and 3 Cowling - Servicing

71-12-01 LH and RH Lower Hinged Cowls - Servicing

3. Maintenance Practices

A. System Verification

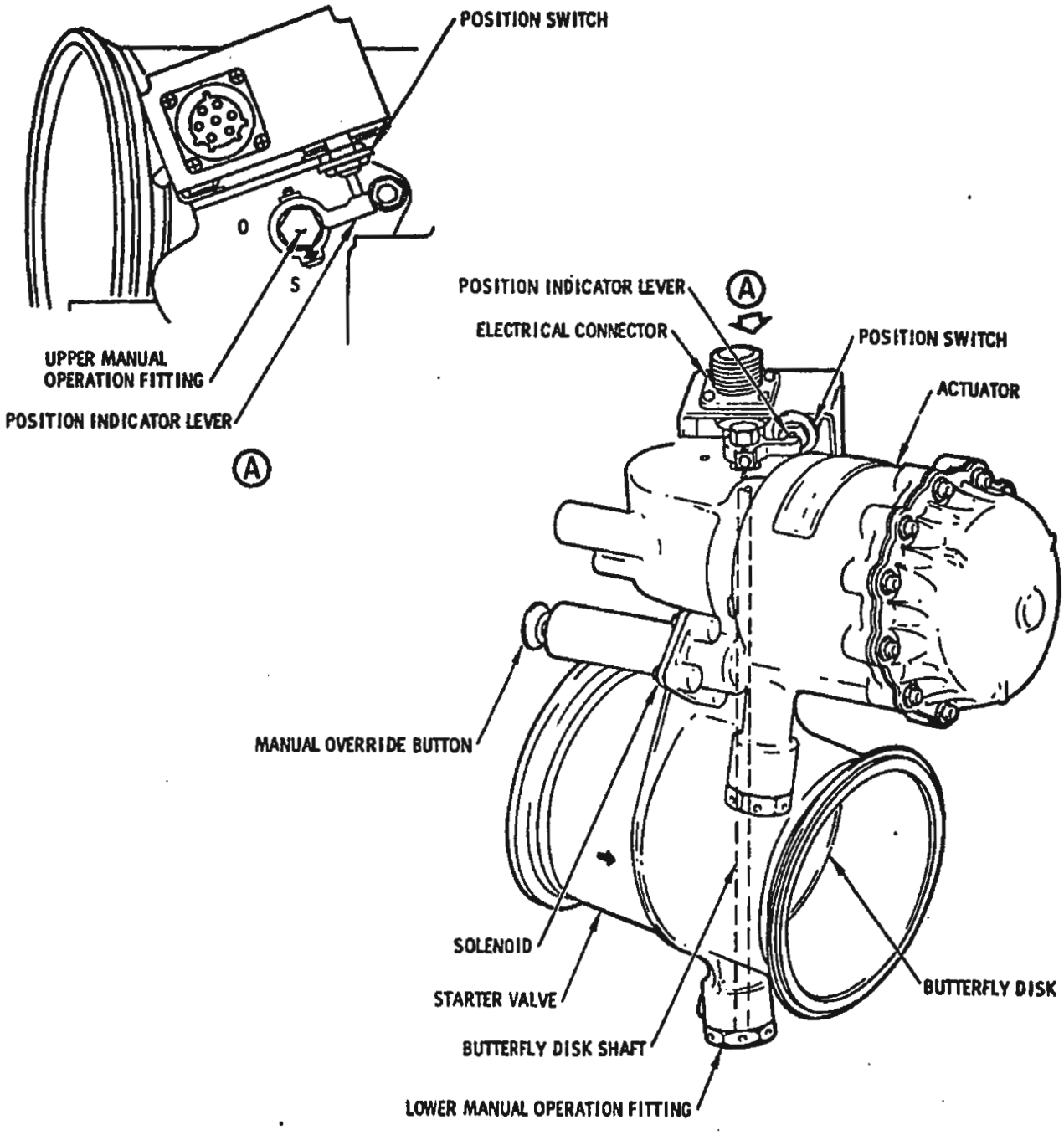
(1) Open applicable engine RH hinged cowl to gain access to starter control valve (Ref. 71-11-00 or 71-12-01).

(2) During engine start, a flight crew member will monitor the N3 indicator and the GND START RELEASE switchlight to ensure that the light illuminating the switch PUSH legend goes out at approximately 51% N3.

(3) Upon notification by the flight crew, verify that the pointer on the upper manual operation fitting of the starter control valve points to S position indicating that the valve is closed (Ref. Fig. 201).

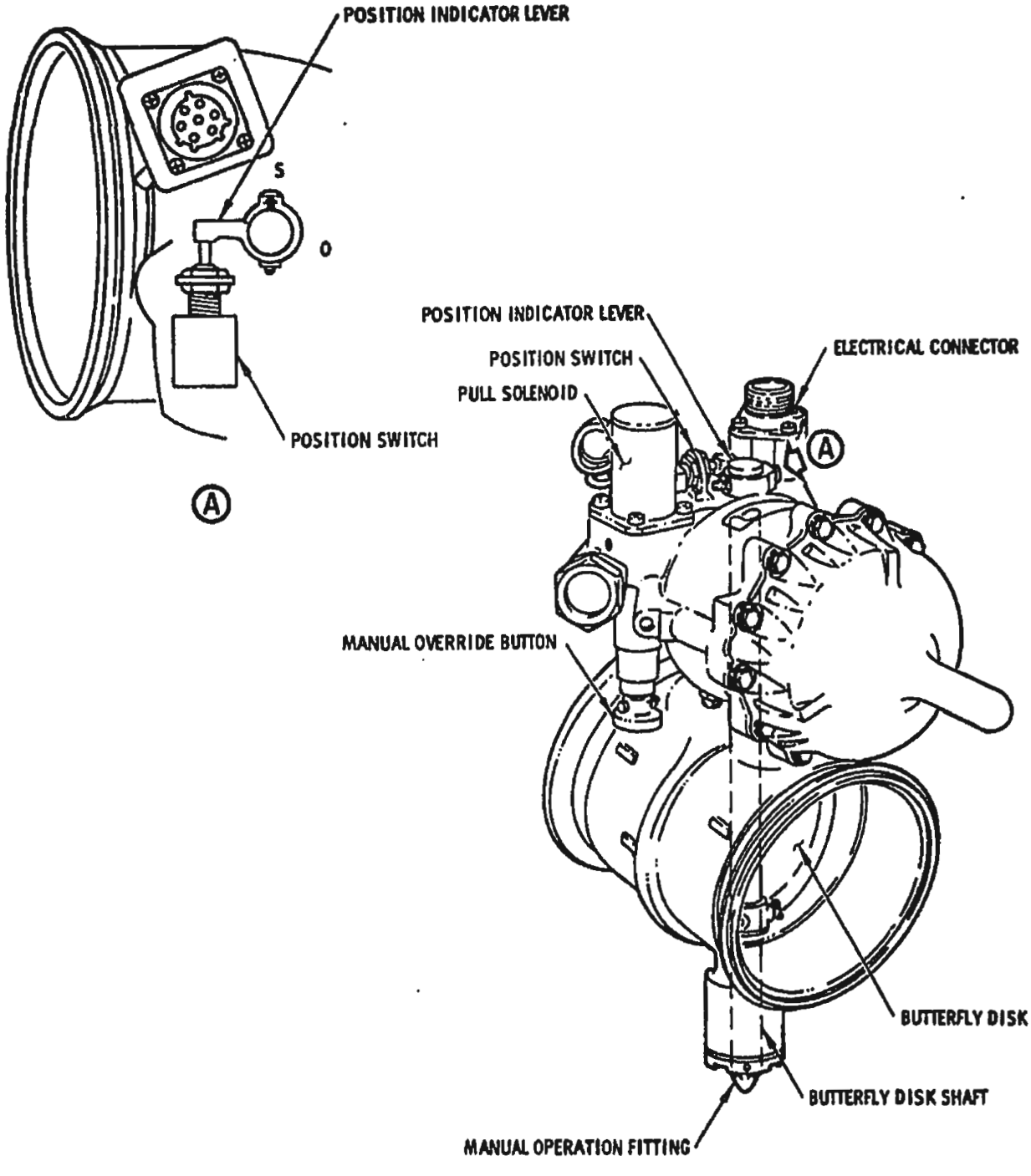
(4) Close cowl opened in Step (1).

(5) Install appropriate placard in flight station. (6) Make appropriate entry in aircraft log book.



MI-0000-80-095

Starter Control Valve
Figure 201



M1-0000-30-096

Starter Control Valve
Figure 201

R EFFECTIVITY: P/N 671513-111 OR LATER VALVES
R
001B

GROUND START SWITCHLIGHT - REMOVAL AND INSTALLATION

1. Relamping

   A. Switchlight

      (1) On Flight Engineer/Second Officers aft circuit breaker panel CB3, zone 215, open and tag circuit breaker START AIR VALVE (N3).

      On pilots overhead circuit breaker panel CB1, zone 210, open and tag applicable engine circuit breaker ENGINE START CONTROL (E13, E14, or E15).

R CAUTION: RELEASE SWITCHLIGHT LATCH LEVER BEFORE PULLING LENS OUT FROM SWITCHLIGHT.

R R (2) Apply light finger pressure under lens assembly to depress latch lever (Ref. Fig. 401).

      (3) Pull lens out and allow it to hang by retainer.

      (4) Remove defective lamp from lens assembly.

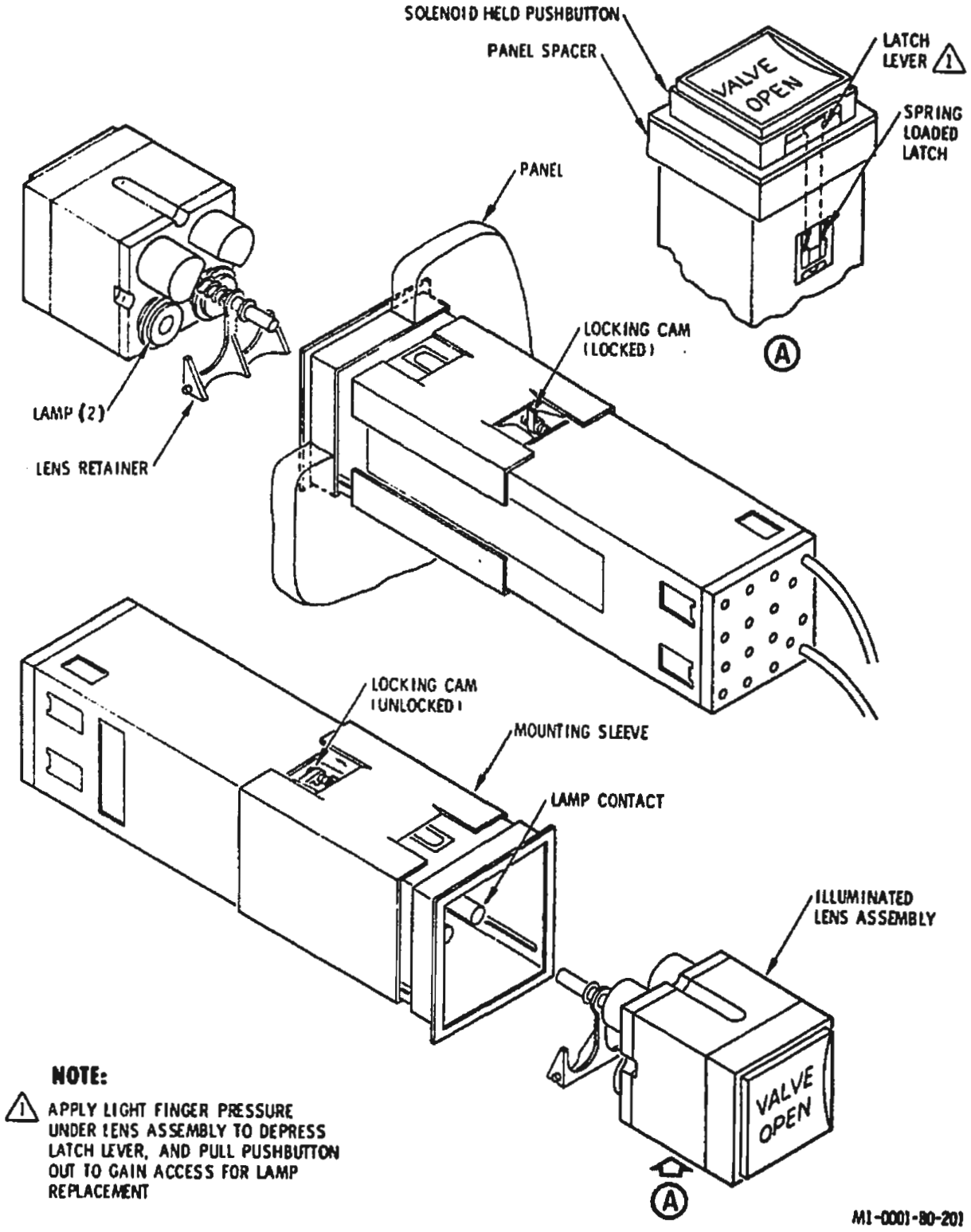
      (5) Install replacement lamp.

      (6) Hold lens assembly with thumb and index finger so that latch lever is on underside of lens and lens legend is indexed properly.

      (7) Insert lens into switchlight housing and depress lens until latch lever is secured.

      (8) Remove tags and close circuit breakers opened in Step (1).

      (9) Depress the LIGHTS TEST switchlight on the pilots overhead panel and verify that replacement lamp is good.



R
R

Switchlight - Relamping
Figure 401

EFFECTIVITY: ALL

001B

CR

ENGINE STARTER OIL SERVICING

1. Equipment and Materials

CR Mobile Jet Oil II

Lock-wire, PN MS20995NC20, or equivalent

Preformed Packing, PN720752-10, Hamilton-Standard, or equivalent

O-ring Seal, PN 69580-1, Hamilton-Standard, or equivalent

R One-half-gallon liquid-pouring container

2. Referenced Procedures

71-11-00	Cowling, Engines No. 1 and 3 - Maintenance Practices
71-12-00	Cowling, Engine No. 2 - Maintenance Practices
80-11-07	Engine Pneumatic Starter - Inspection and Check

3. Servicing

WARNING: TURBO OIL MAY CAUSE SEVERE INFLAMMATION OF SKIN THROUGH PROLONGED CONTACT. TURBO OIL MAY ALSO DAMAGE CLOTHING AND PAINT.

CR CR CAUTION: DO NOT USE UNAPPROVED BRANDS OR TYPES OF OIL. DO NOT MIX BRAND NAME OILS UNLESS SPECIFICALLY AUTHORIZED.

NOTE: This servicing function is normally performed following engine installation, before cowl panels have been installed. Refer to 71-11-00 or 71-12-00 for instructions relating to opening and closing of cowling if starter replacement is performed at any other time.

CR A. Replenishing Engine Pneumatic Starter

(1) On Flight Engineer/Second Officers aft circuit breaker panel CB3, zone 215, open and tag applicable START AIR VALVE circuit breaker.

CR (2) Remove servicing plug from oil fill port.

R R (3) Place container and funnel under starter oil drain plug.

(4) Remove magnetic plug and visually inspect for metal particles. Reinstall plug with new O-ring seal and torque 5 to 15 lb in. (Ref. 80-11-07).

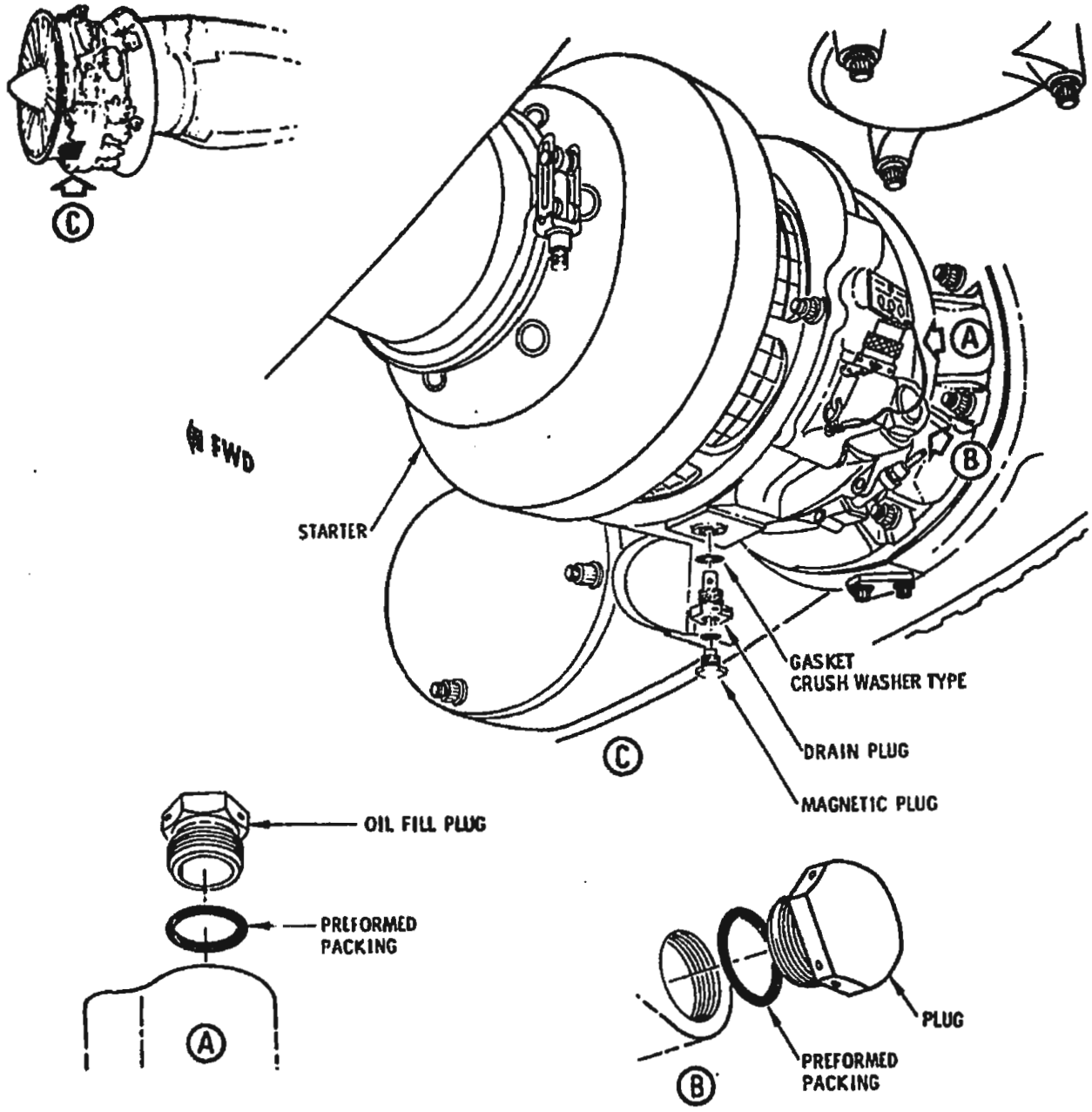
(5) Remove drain plug with magnetic plug, and drain oil.

CR CR (6) Replace clean drain plug, using new crush washer type gasket. Torque drain plug 10 to 25 lb in. and lock-wire.

C (7) Add oil to the top of the fill port (9 oz).

C C C (8) Discard used preformed packing and install new packing on fill plug. Install plug and torque 20 to 25 lb. in. and lockwire.

C. C (9) Remove tag and close circuit breaker opened in Step 3.A.(1).



NOTE
OIL SIGHT PLUG REPLACED BY PLUG

M1-0001-80-068

CR
CR

Starter Oil Servicing
Figure 301

EFFECTIVITY: ALL

001B

ENGINE PNEUMATIC STARTER - REMOVAL AND INSTALLATION

1. Equipment and Materials

CR Mobil Jet II, or equivalent

Lock-wire, PN MS20995NC20, or equivalent

Oil Servicing cart Model 550 LPT, Loe Industries, or equivalent

One-half-gallon liquid-pouring containerPreformed Packing, PN720752-10, Hamilton - Standard, or equivalent

Preformed Packing, PN69490D216, Hamilton - Standard, or equivalent

2. Referenced Procedures

20-36-02	Double T-bolt V-band Coupling - Removal and Installation
70-12-02	V-Band Coupling Clamps - Maintenance Practices
71-11-00	Cowling, Engines No. 1 and 3 - Maintenance Practices
71-12-00	Cowling, Engine No. 2 - Maintenance Practices
80-11-07	Engine Pneumatic Starter - Servicing
80-11-07	Engine Pneumatic Starter - Adjustment and Test

3. Removal/Installation

A. Removal

(1) On Flight Engineer/Second Officers aft circuit breaker panel CB3, zone 215, open and tag applicable START AIR VALVE circuit breaker N3, N9, or N15.

(2) Open LH hinged cowl (eng No. 1 or 3) or lower LH cowl access door (eng No. 2) to gain access to engine starter (Ref. 71-11-00 or 71-12-00).

(3) Drain oil from starter (Ref. 80-11-07).

(4) Remove double T-bolt V-band coupling (Ref. 20-36-02 and 70-12-02) that connects starter duct to starter inlet flange, zone 412, 422, or 432, (Ref. Fig. 401).

CAUTION: ENSURE STARTER MOTOR IS PROPERLY SUPPORTED.

(5) Remove quick attach-detach (QAD) clamp connecting starter to adapter housing as follows:

(a) Remove locknut and discard.

(b) Expand clamp and move aft over adapter housing flange.

NOTE: Leave clamp in place on the adapter housing.

(6) Move starter forward to disengage adapter splines and starter clutch shaft splines. Remove QAD clamp and retain for reuse.

(7) Remove and discard clutch shaft preformed packing.

(8) Inspect exposed surface of V-flange seal (E-seal) in flange of starter duct for deformation, nicks, dents, or tears. Replace seal if damaged (Ref. 70-12-02).

NOTE: A starter drive shaft failure or damaged pawls can result in external gear box damage.

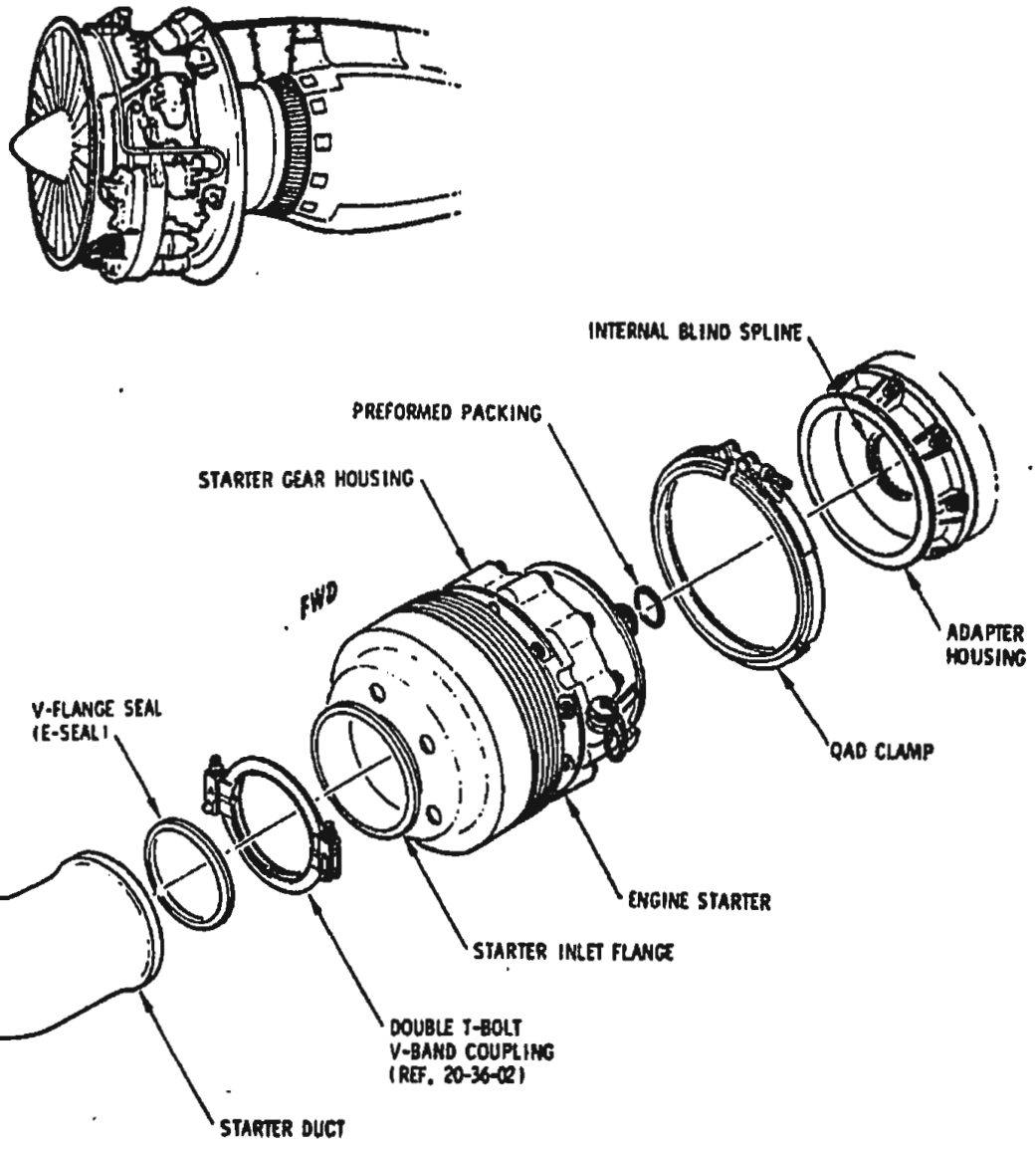
E-seals are manufactured slightly out-of-round for secure fit in male portion of ducting joints. Do not remove any seal for inspection if it appears to be in satisfactory condition.

(9) If starter is not to be replaced in aircraft immediately, place dust cover over adapter housing, and seal end of starter pneumatic duct. Place dust cover over inlet flange end of starter.

B. Installation

(1) Verify that circuit breaker opened in Step 3A(1) is open and tagged.

(2) Lubricate a new starter clutch shaft preformed packing with Turbo Oil 2380, or equivalent, and install packing in groove (Ref. Fig. 401). and install packing in groove (Ref. Fig. 401). Verify that V-Flange seal (E-seal) is installed in duct and that flanges are clean.



M1-0104-80-011

Engine Starter - Removal and Installation
Figure 401

(3) Position QAD clamp over and behind adapter housing flange.

(4) Raise starter to mate with adapter housing on engine external gearbox. Drain plug should be at the 6-o'clock position so starter gear housing blind (indexing) spline will be aligned with adapter housing internal blind spline.

(5) Engage clutch shaft splines with gearbox input shaft, and mesh gear housing splines with adapter splines.

(6) When gear housing flange is mated to adapter housing flange, install QAD clamp as follows:

(a) Position QAD clamp over the starter motor/adapter housing flanges.

(b) Install new locknut and torque to value specified on clamp.

NOTE: Torque value for normal duty clamp is 45 to 50 lb in. and for heavy duty clamp is 60 to 65 lb in.

(7) Mate starter duct to inlet flange of starter and secure with double T-bolt V-band coupling (Ref. 20-36-02 and 70-12-02).

WARNING: TURBO OIL MAY CAUSE SEVERE INFLAMMATION OF SKIN THROUGH PROLONGED CONTACT.

CAUTION: DO NOT USE UNAPPROVED BRANDS OR TYPES OF TURBO OIL.

C (8) Fill starter until it overflows the filler boss.

C (9) Install filler plug with new preformed packing. Torque
C plug 20 to 35 lb in. and lock-wire.

(10) Verify that two-piece magnetic drain plug is
R lock-wired. If not, torque self-sealing drain plug 10
R to 25 lb in. and magnetic plug 5 to 15 lb in. and lock-wire.

(11) Close cowl panel (Ref. 71-11-00 or 71-12-00).

(12) Remove tag and close circuit breaker opened in Step 3A(1).

(13) Perform an operational test (Ref. 80-11-07).

ENGINE PNEUMATIC STARTER - ADJUSTMENT AND TEST

1. General

This procedure contains information necessary for checking air pressure available at engine starter inlet.

2. Equipment and Materials

R Pressure Check Connector, Rolls-Royce Ltd., PN UT.979, or
R equivalent

R A locally manufactured hose and pressure gauge assembly is
R required to perform this check

Lock-wire Fed Spec QQ-W-390, 0.032-inch diameter, or equivalent

3. Referenced Procedures

36-13-00	Pneumatic Systems - Maintenance Practices
49-00-01	Auxiliary Power Unit (APU) - Adjustment/Test
71-00-00	Power Plant - Adjustment and Test
71-11-00	Cowling, Engines No. 1 and No. 3 - Servicing
71-12-01	LH and RH Lower Hinged Cowls - Servicing

4. Adjustment/Test

A. Starter Inlet Pressure Check

(1) Open LH hinged cowl 413A or 423A for engines No. 1 or 3 (Ref. 71-11-00) or 433AL for engine No. 2 (Ref. 71-12-01).

(2) Remove blank from test point (Ref. Fig. 501).

(3) Connect pressure check connector to test point.

R (4) Connect hose and pressure gauge assembly to pressure check connector.

R (5) Start APU (Ref. 49-00-01) or connect external air
R supply (Ref. 36-13-00).

R (6) Determine minimum bleed air for starting (Ref. 71-00-00) then record actual bleed air system pressure, from Flight Engineer/Second Officers bleed air panel before performing dry motoring cycle.

R (7) Perform a Dry Motoring Cycle (Ref. 71-00-00) and at commencement of motoring cycle record pressure on pressure gauge. This pressure must not be more than 4 to 6 psig below bleed air system pressure recorded in Step (6).

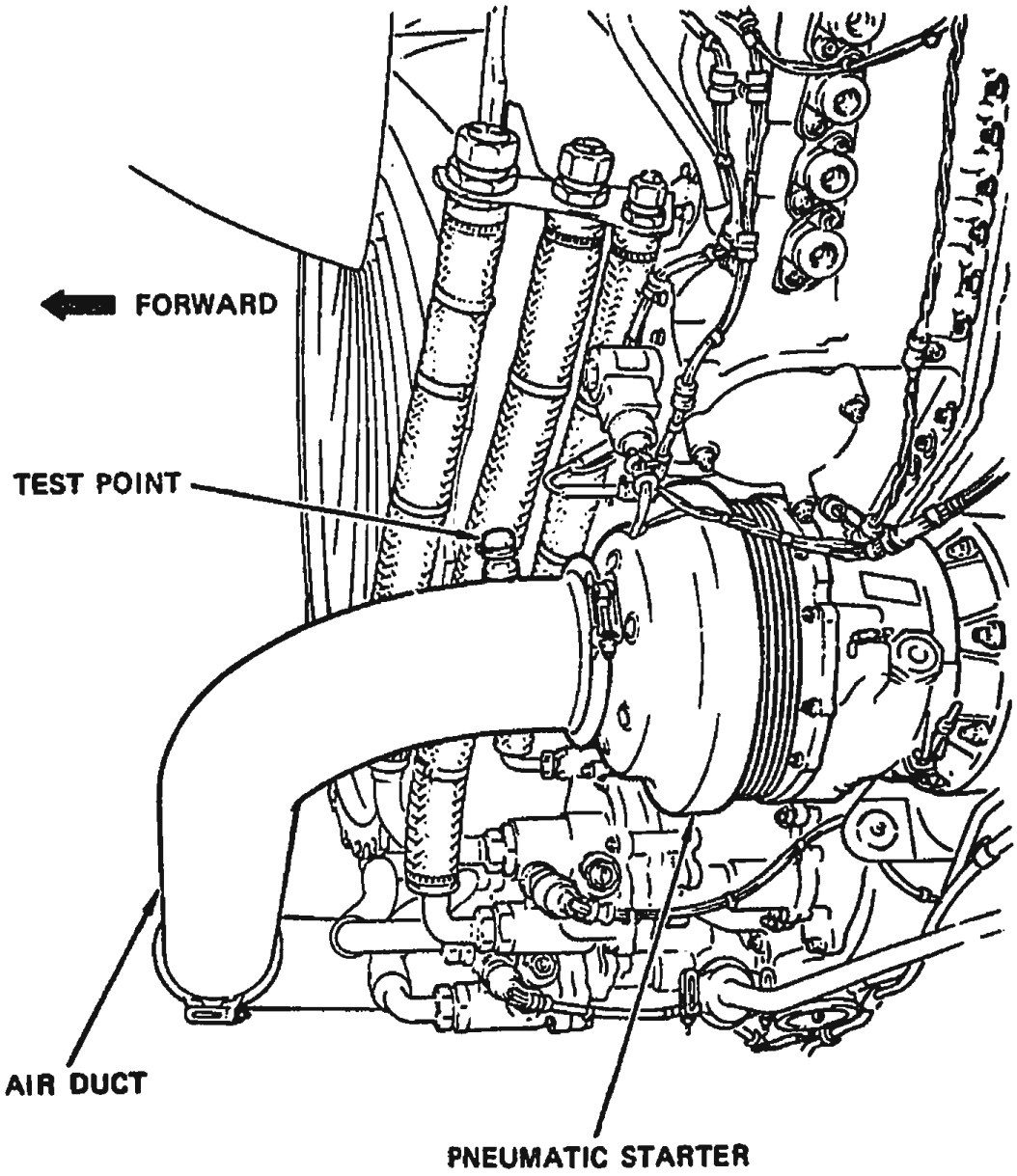
R (8) Stop APU (Ref. 49-00-01) or disconnect external air supply (Ref. 36-13-00) as applicable.

R (9) Disconnect hose and pressure gauge assembly from pressure check connector.

R (10) Disconnect pressure check connector from test point (Ref. Fig. 501).

R (11) Fit blank to test point and lock-wire.

R (12) Close applicable hinged cowl.



M1-0100-80-016
31463

Starter Inlet Pressure Check
Figure 501

ENGINE PNEUMATIC STARTER - INSPECTION AND CHECK

1. Equipment and Materials

ESSO/ENCO Turbo Oil 2380, or

Lubricating Oil, MIL-L-23699 (for normal operation), or equivalent

Lubricating Oil, MIL-L-7808 (for extended ground operation below -40 degrees F), no equivalent

Lock-wire, PN MS20995C20, or equivalent

Oil Servicing Cart, Model 550 LPT, Loe Industries, or equivalent

One-half-gallon liquid-pouring container

R Preformed packing, PN 720752-10, or equivalent

R Preformed packing, PN 720752-14, or equivalent

R Preformed packing, PN 720752-33, or equivalent

R O-ring seal, PN NAS 1595-2, or equivalent

NOTE: Oil servicing equipment and materials are required only if oil is drained for packing replacement.

2. Referenced Procedures

71-11-00	Cowling, Engines No. 1 and 3 - Maintenance Practices
71-12-00	Cowling, Engine No. 2 - Maintenance Practices
80-11-07	Engine Pneumatic Starter - Servicing
80-11-07	Engine Pneumatic Starter - Removal and Installation

3. Inspection/Check

A. External Inspection

(1) On Flight Engineer/Second Officers circuit breaker panel CB3, zone 215, open and tag applicable START AIR VALVE circuit breaker.

(2) Open LH hinged cowl (Eng. No. 1 or 3) or lower LH cowl access door (Eng. No. 2) to gain access to engine starter (Ref. 71-11-00 or 71-12-00).

(3) Examine starter drain plug, oil fill port quick-disconnect (QD) coupling, oil level sight plug, screened port, gear housing vent, and starter external surfaces next to mating joints for evidence of oil leakage (Ref. Fig. 601).

(a) If leakage is evident at any place other than plug, oil fill QD coupling, or sight plug or screened port locations, the starter must be replaced (Ref. 80-11-07).

(b) Correct leakage at oil fill QD coupling by removing coupling, replacing preformed packing (P/N 720752-14) , and reinstalling coupling. Torque QD coupling 20 to 35 lb in. and lock-wire.

(c) If leakage is evident at oil level sight plug, correct condition only after draining starter or internal inspection (Ref. Para. 3B) and verifying that starter is serviceable.

(d) If leakage is evident at magnetic drain plug, correct condition in accordance with Paragraph 3B.

(e) If leakage is evident at the screened port (housing side vent) check for over servicing of oil quantity. Oil servicing to the proper level will usually correct leakage from this port. If leakage continues after correct oil level servicing the starter must be replaced.

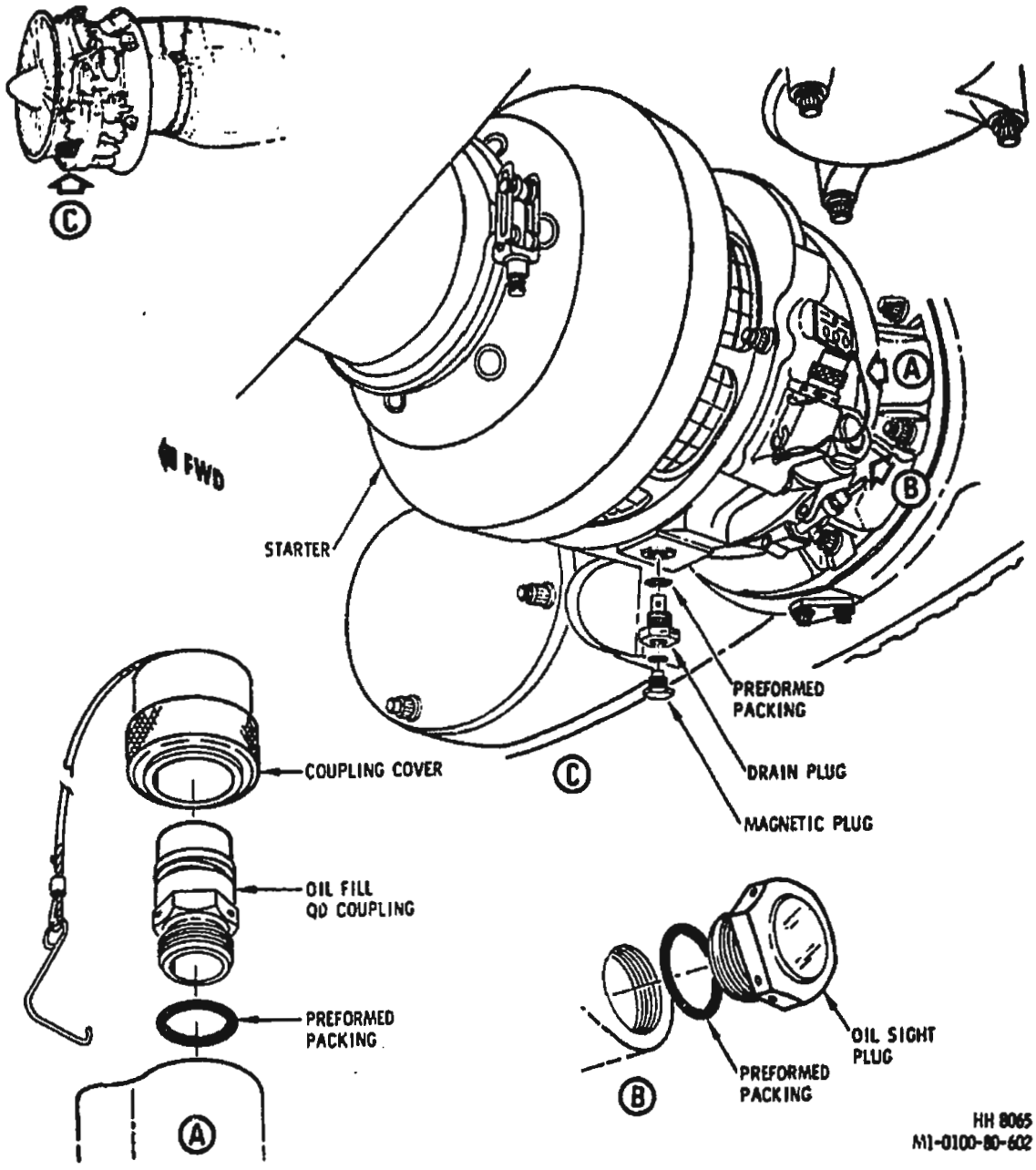
B. Internal Inspection

(1) Perform internal inspection only after completing external inspection (Ref. Para. 3A).

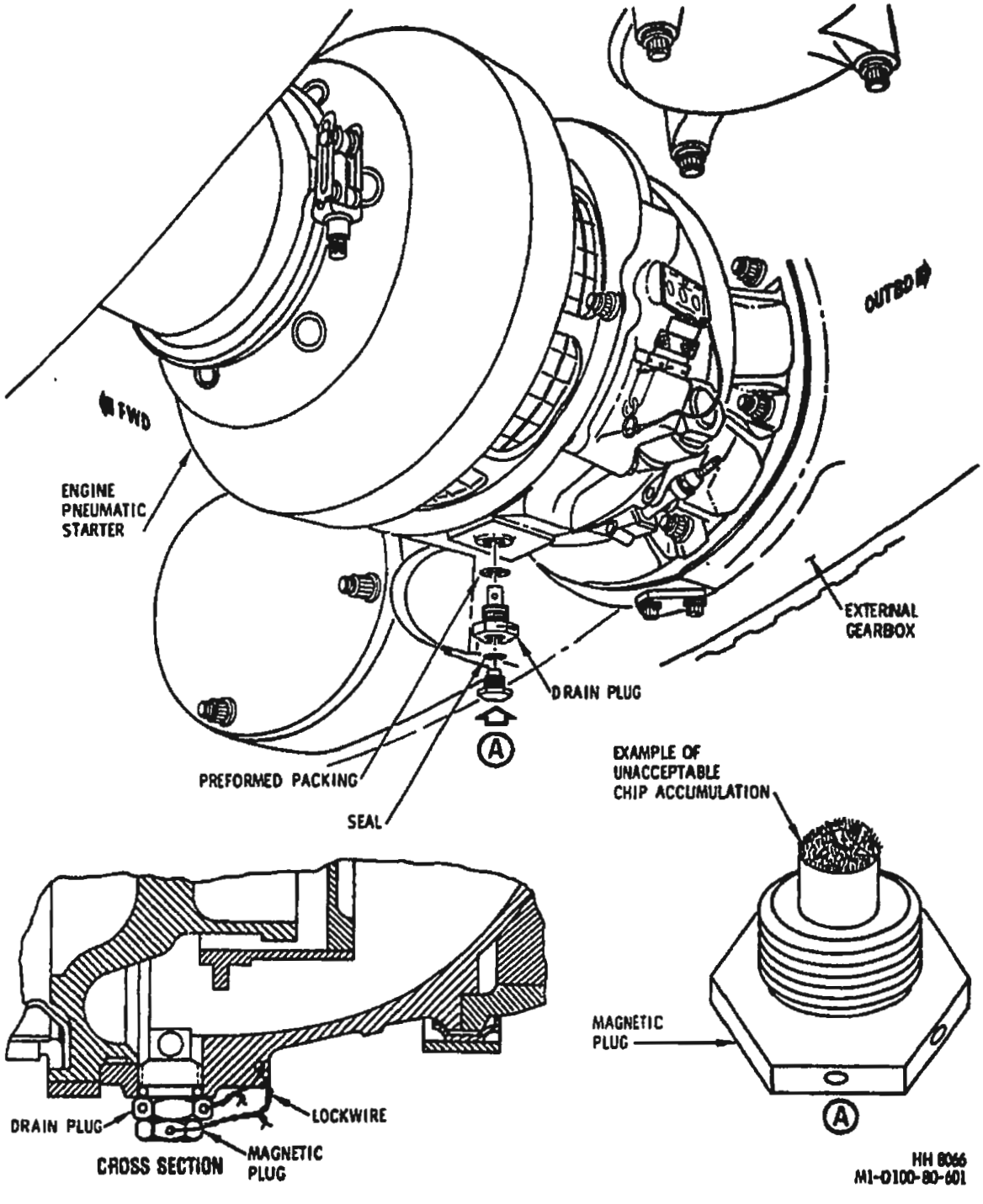
(2) Remove magnetic plug from drain plug.

(3) Examine magnetic plug for metal particles or presence
R of fragments. Any amount of fuzzlike particles are
R acceptable. If any single fragment exceeds 0.1 inch
R (2.54mm) in any dimension, replace starter (Ref. Fig.
R 602 and 603).

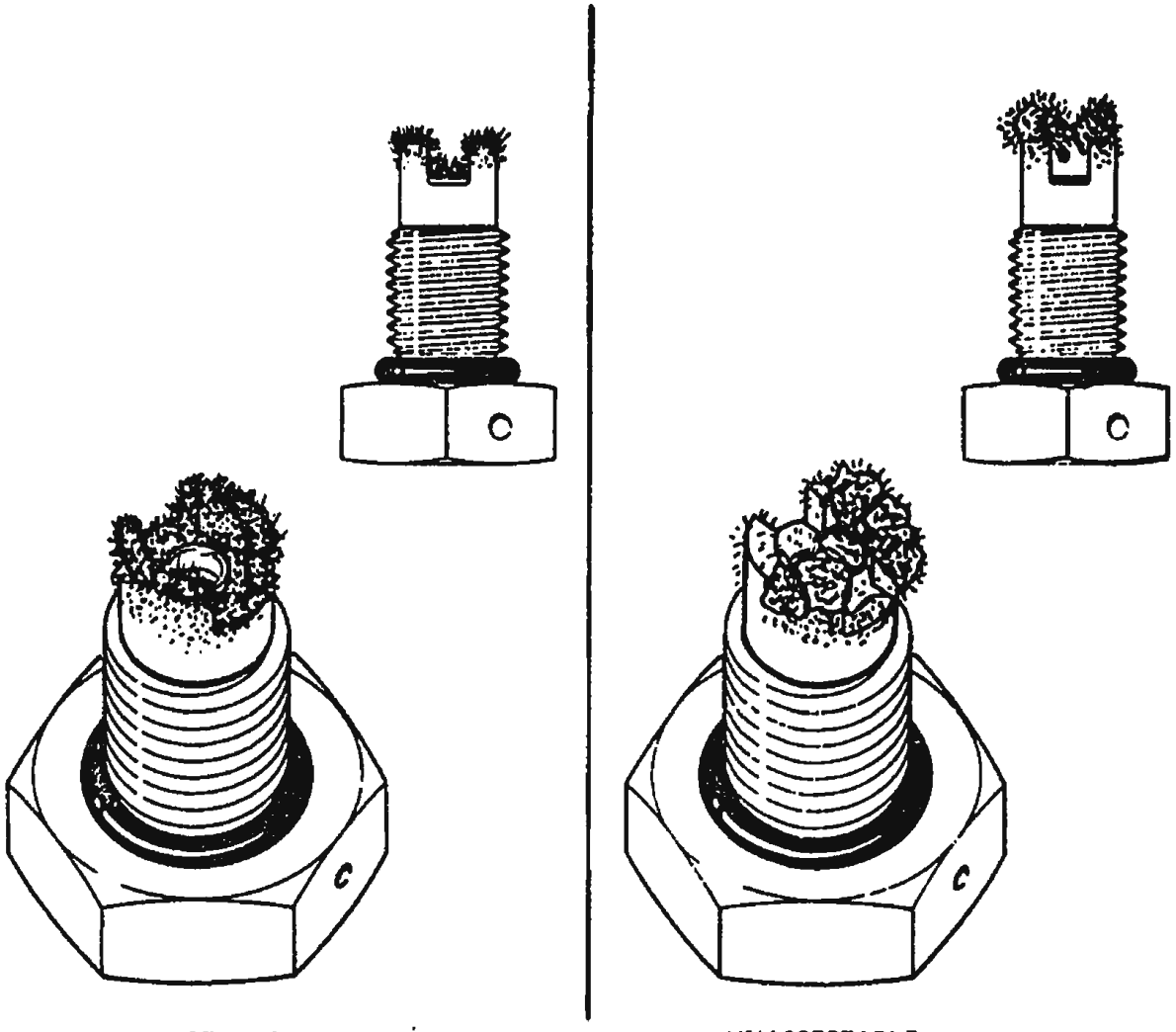
(4) If magnetic plug does not contain unacceptable material, replace O-ring seal (P/N NAS1595-2), and
R install plug in drain plug. Torque magnetic plug 5 to



Engine Starter Inspection
Figure 601



Pneumatic Starter Oil Reservoir Inspection and Check
Figure 602



ACCEPTABLE

METAL PARTICLES DO NOT EXCEED 0.1 INCH (2.5 MM) IN ANY DIMENSION

UNACCEPTABLE

METAL PARTICLES EXCEED 0.1 INCH (2.5 MM) IN SIZE

M1-0001-80-133

R Magnetic Plug Inspection and Check
R Figure 603

R 15 lb in. and lock-wire, unless drain plug leakage is detected.

(5) If oil leakage is evident at drain plug or at oil level sight plug, drain oil from starter (Ref. 80-11-07).

(6) Remove leaking drain plug (with magnetic plug), replace preformed packing (P/N 720752-10) , and reinstall plug. Torque plug 10 to 25 lb in. and lock-wire as shown in Fig. 601.

(7) Remove leaking oil level sight plug, replace preformed packing (P/N 720752-33) , and reinstall plug. Torque plug 45 to 60 lb in. and lock-wire.

(8) Replenish starter with oil (Ref. 80-11-07). (9) Close cowl panel (Ref. 71-11-00 or 71-12-00).

(10) Remove tag and close circuit breaker opened in Step 3A(1).

STARTER CONTROL VALVE - MAINTENANCE PRACTICES

1. Referenced Procedures

6-40-00	Exterior Access Doors and Panels
71-11-00	Engines No. 1 and 3 Cowling - Servicing
71-12-01	LH and RH Lower Hinged Cowls - Servicing

2. Maintenance Practices

The following procedure specifies the method used to manually operate the starter control valve. The valve may be operated by either the manual override button or by the manual operation fittings.

The procedure also specifies the method to determine that the starter control valve is closed after engine start if the valve indicator light is inoperative.

3. Manual Operation

A. Manual Override Pushbutton

(1) Open applicable engine access panel 414B or 424B (Eng. No. 1 or 3) or 434BR (Eng. No. 2) to gain access to starter control valve (Ref. 6-40-00).

R R WARNING: WEAR PROTECTIVE GLOVES WHEN WORKING ON BLEED AIR SYSTEM.

(2) Upon notification by the flight crew, depress and hold manual override button (Ref. Fig. 201).

(3) Upon notification by the flight crew, release the override button.

(4) Verify that pointer on upper manual operation fitting points to S position indicating that valve is closed.

(5) Close access panel opened in Step 3A(1).

B. Manual Operation Fitting

(1) Open applicable engine RH hinged cowl to gain access to starter valve (Ref. 71-11-00 or 71-12-01).

R R WARNING: WEAR PROTECTIVE GLOVES WHEN WORKING ON BLEED AIR SYSTEM.

(2) Upon notification by the flight crew, use applicable wrench and turn either upper or lower manual operation fitting until arrow on upper fitting points to O position (Ref. Fig. 201).

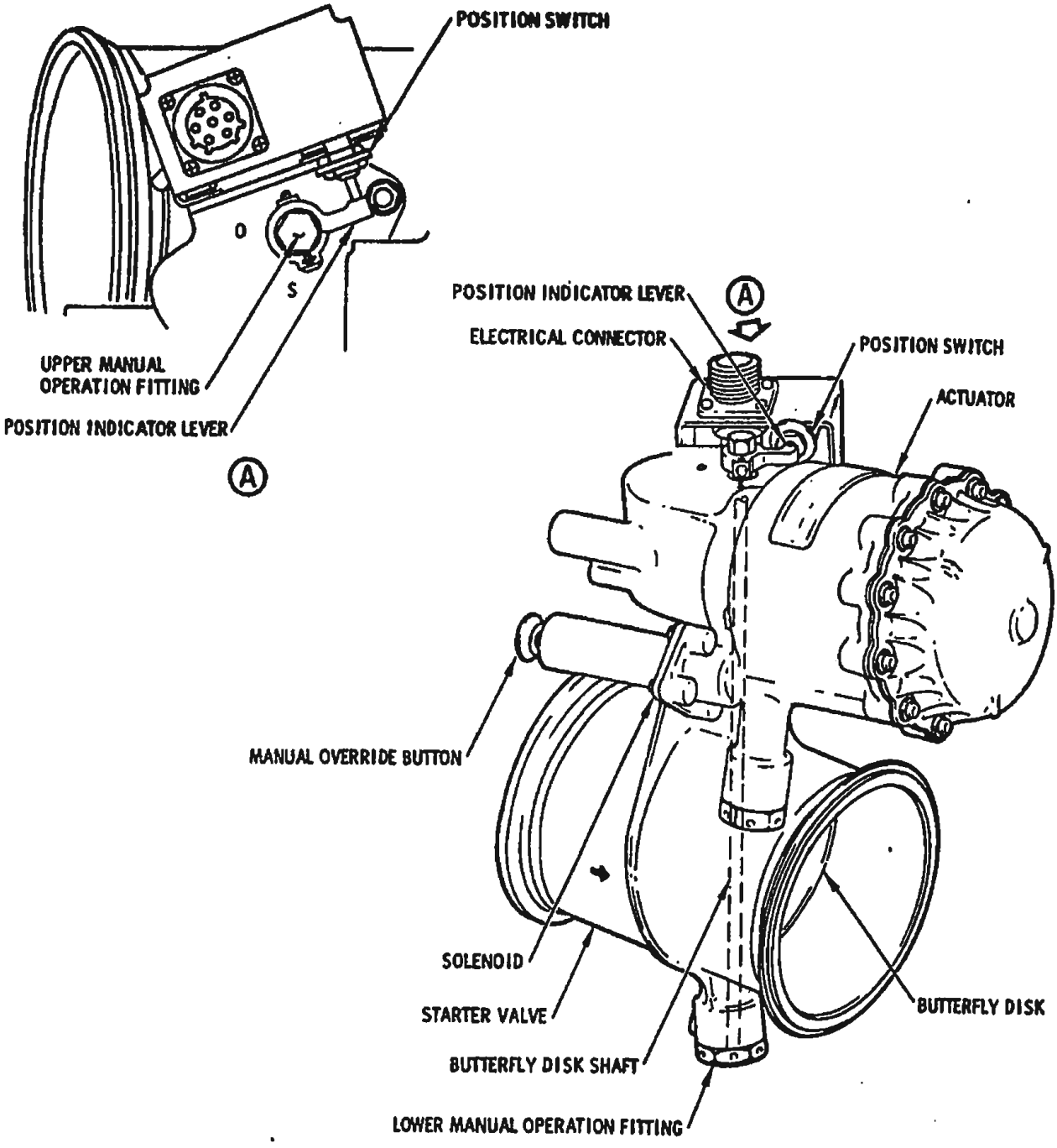
R R R NOTE: It will be necessary to maintain the opening force on the valve throughout the start sequence.

(3) Upon notification by the flight crew, turn the manual operation fitting until the arrow points to S position.

(4) Close cowl opened in Step 3B(1).

R (5) Install appropriate placard in flight station.

R (6) Make appropriate entry in aircraft log book.



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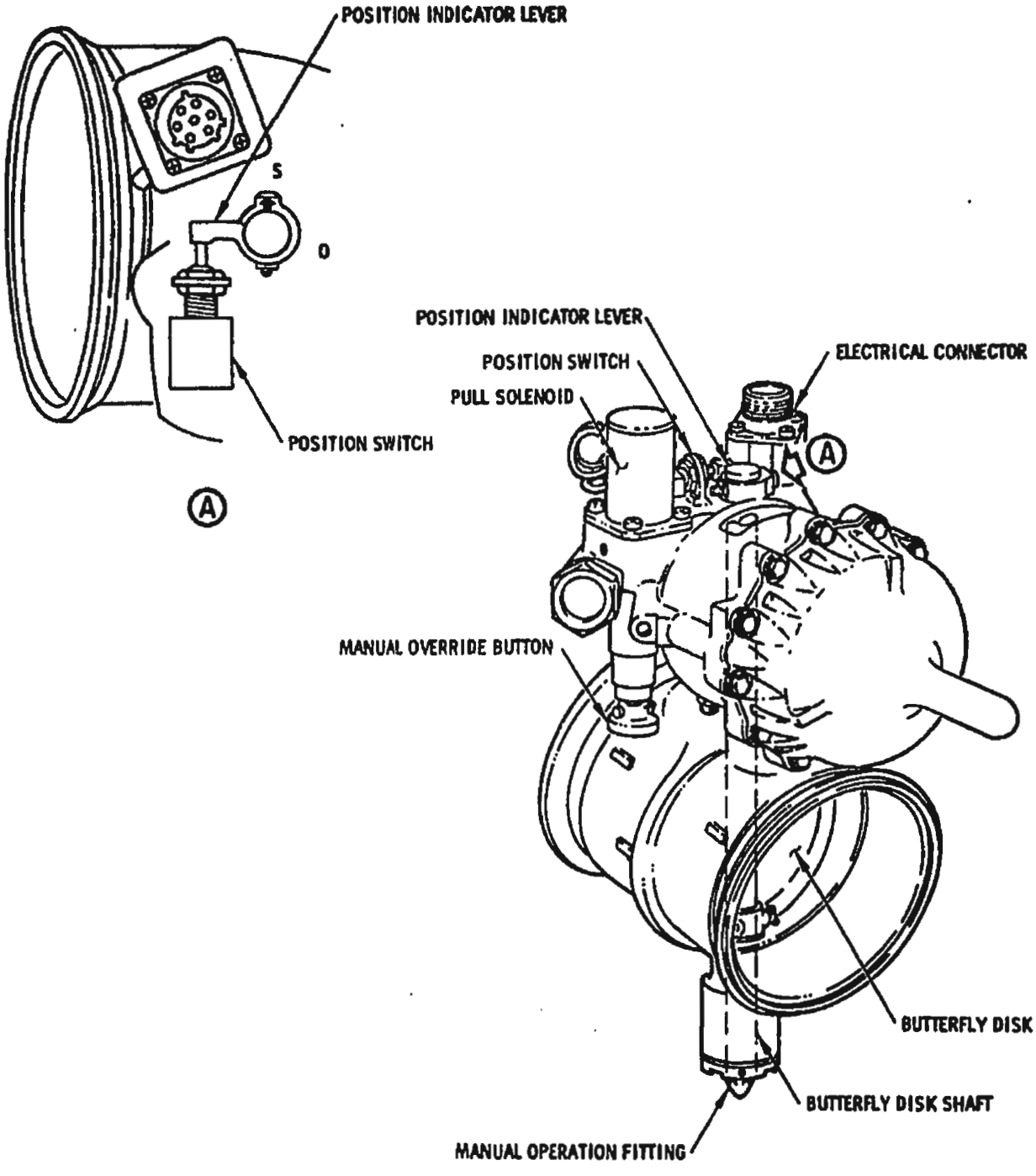
Starter Control Valve
Figure 201



Starter Control Valve
Figure 201

R EFFECTIVITY: P/N 671513-111 OR LATER VALVES
R
001B

ENGINE STARTER CONTROL VALVE - REMOVAL AND INSTALLATION

1. Equipment and Materials

Extractor Tool, PN AVT. 2819, or equivalent

2. Referenced Procedures

	20-36-02	Double T-bolt V-band Coupling - Removal and Installation
R	49-00-01	Auxiliary Power Unit (APU) - Adjustment/Test
	70-12-02	V-band Coupling Clamps - Maintenance Practices
	71-11-00	Cowling, Engines No. 1 and No. 3 - Servicing
	71-12-01	LH and RH Lower Hinged Cowl - Servicing

3. Removal/Installation

A. Removal

(1) On Flight Engineer/Second Officers aft circuit breaker panel CB3, zone 215, open and tag applicable START AIR VALVE circuit breaker.

(2) Open applicable RH hinged cowl 414A or 424A for engines No. 1 and 3 (Ref. 71-11-00) or 434AR for engine No. 2 (Ref. 71-12-01). Disconnect electrical plug from receptacle at top of applicable starter actuator valve, zone 412, 422, or 432, (Ref. Fig. 401).

R R (3) Ensure external air supply is disconnected from Bleed Air System and APU is shutdown (Ref. 49-00-01).

WARNING: ENSURE MANIFOLD BETWEEN ENGINE ISOLATION VALVE AND STARTER CONTROL VALVE IS DEPRESSURIZED.

R (4) Remove double T-bolt V-band couplings (Ref. 20-36-02 and 70-12-02) to separate starter control valve from upstream and downstream starter ducting.

R (5) Withdraw starter control valve from ducting. Avoid using tools that might damage internal V-flange seals (E-seals). One seal is located in downstream flange of starter valve. The other seal is located in upstream starter ducting flange.

R (6) Inspect E-seals for deformation, nicks, dents, or tears. Using extractor tool, remove and replace any damaged seals. Undamaged seals should not be removed.

NOTE: E-seals are manufactured slightly out-of-round for secure fit in male portion of ducting joints. Most common defects will be nicks, dents, cuts, or deformation from flat plane. Do not remove any seal for inspection if it appears to be in satisfactory condition.

B. Installation

(1) Verify that circuit breaker opened in Step 3A(1) is open and tagged.

(2) Before installing starter control valve, place V-flange seal (E-seal) in inner recess of flange at outlet of starter valve (Ref. 70-12-02).

(3) Verify that E-seal is installed in flange of upstream starter ducting and that flanges are clean.

(4) Install starter control valve between starter ducting sections, ensuring that duct and valve installation alignment pads are aligned. Secure with double T-bolt V-band couplings positioning clamps to give maximum clearance with adjacent structure and cowl, (Ref. 20-36-02 and 70-12-02).

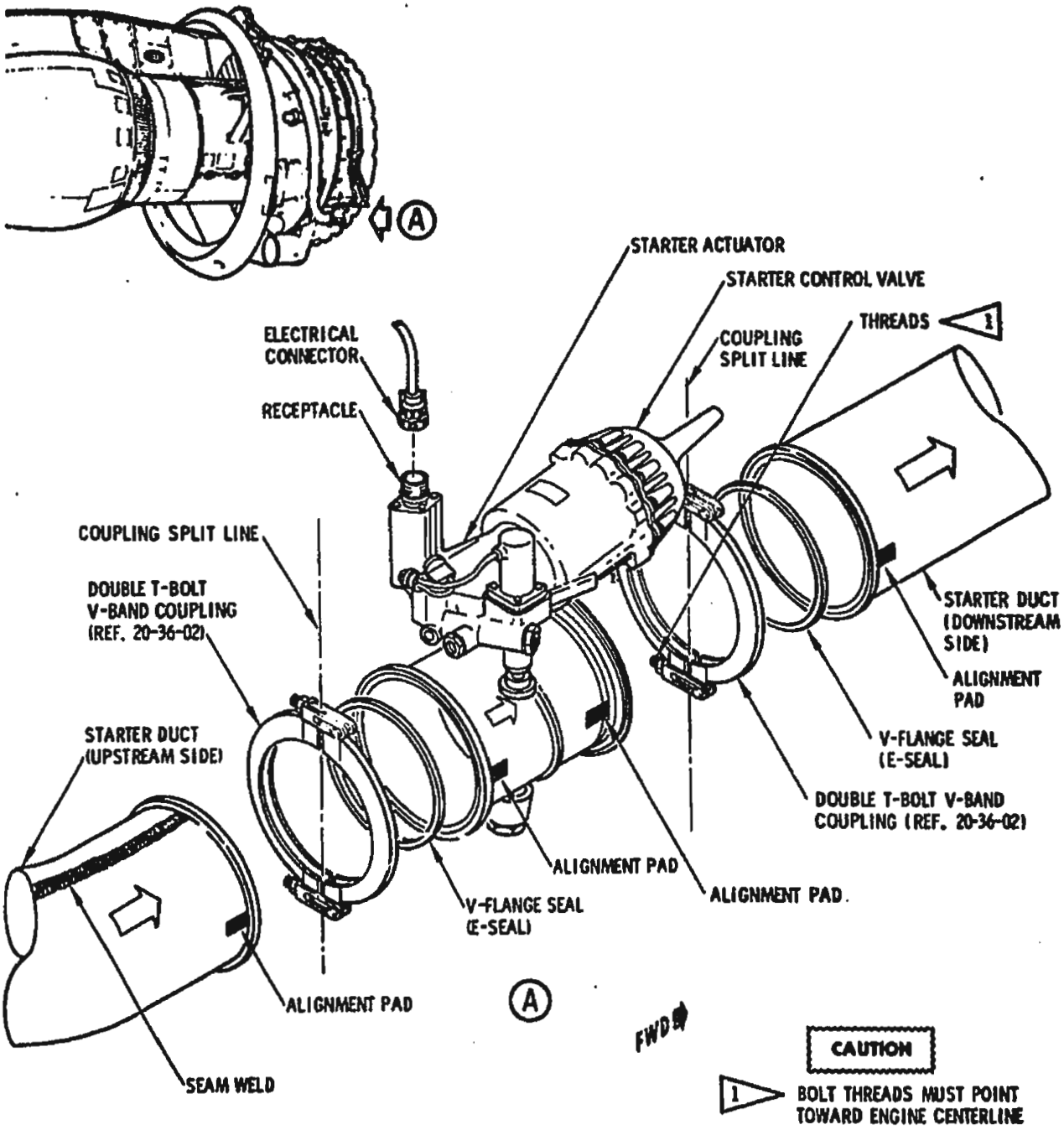
CR CR CR NOTE: To ensure maximum clearance with cowl. Position clamp so T-bolt nuts are pointing towards engine centerline.

(5) Connect electrical plug connector to starter actuator receptacle.

(6) Remove tag and close circuit breaker opened in Step 3A(1).

(7) Verify operation of starter control valve on next engine run.

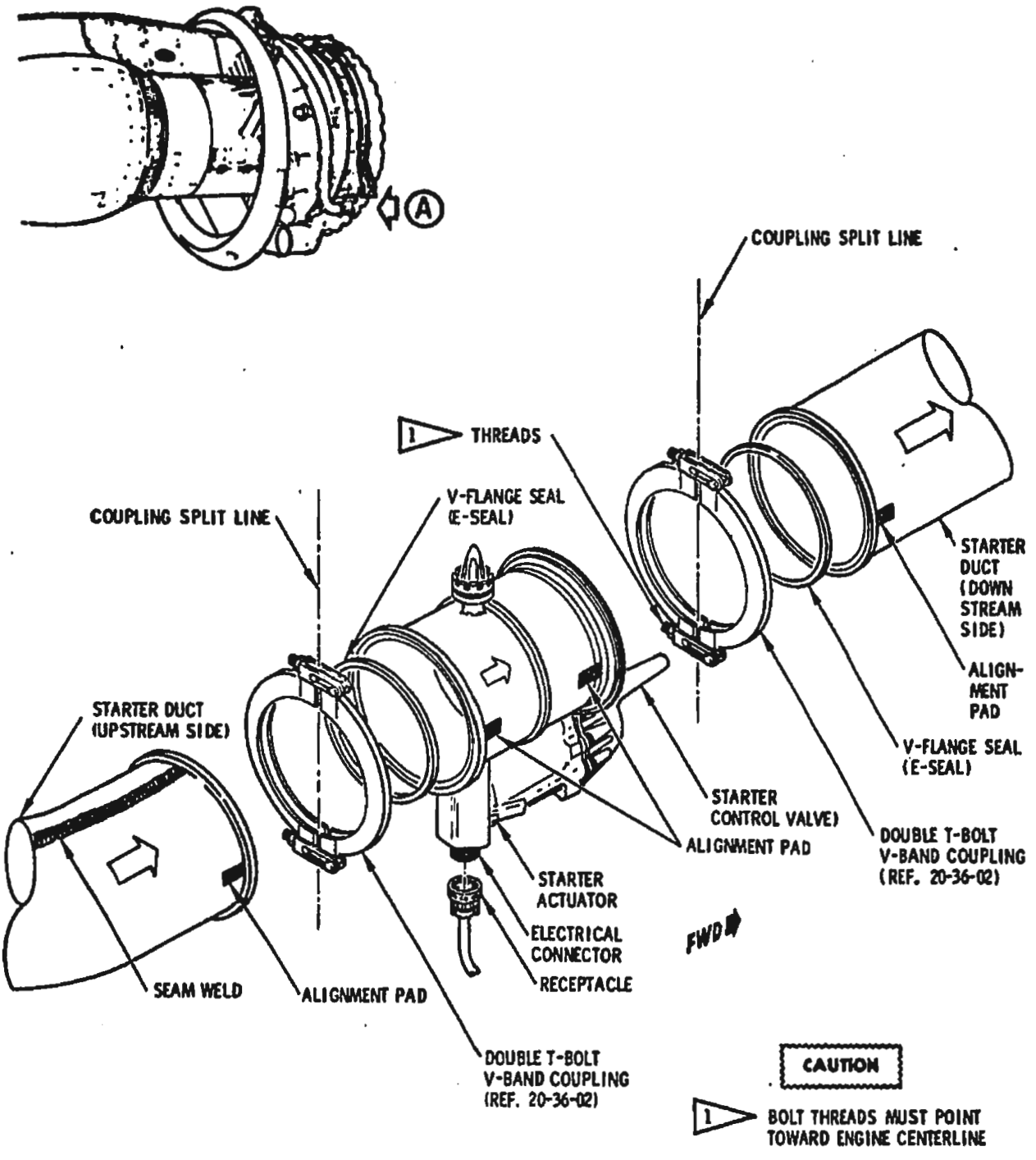
(8) Close cowl opened in Step 3A(2).



M1-0000-80-131

C
C
C
Engine Starter Control Valve
Removal and Installation
Figure 401

R
R
001B
EFFECTIVITY: WITH VALVE ACTUATOR FACING UP



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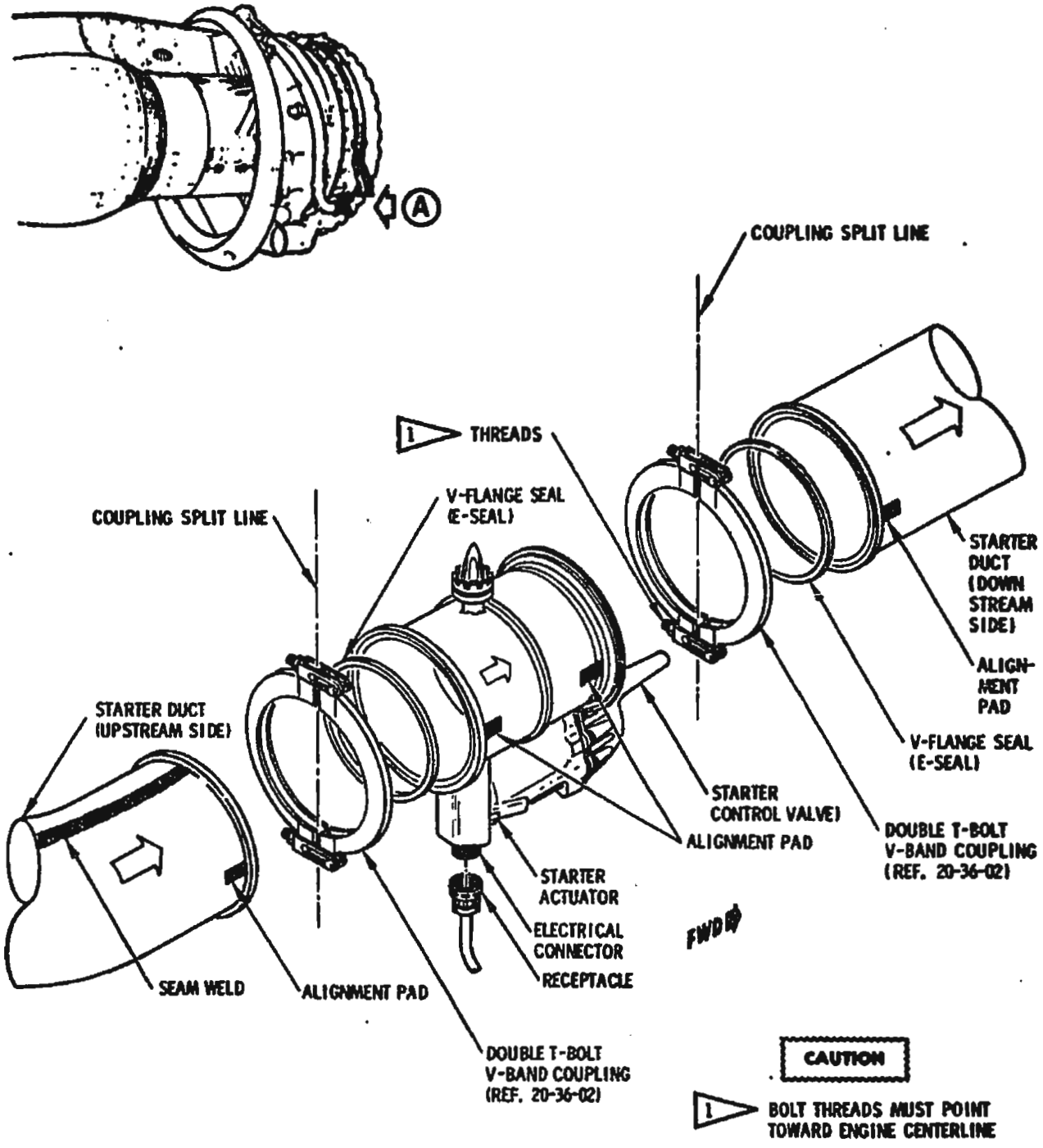
C C C Engine Starter Control Valve
Removal and Installation
Figure 401

R R 001B EFFECTIVITY: WITH VALVE ACTUATOR FACING DOWN



M1-0000-80-132

CR Engine Starter Control Valve
CR Removal and Installation
CR Figure 401

EFFECTIVITY: 032-999 WITH
Valve Actuator Facing Down

001B

ENGINE STARTER CONTROL VALVE - INSPECTION AND CHECK

1. Referenced Procedures

71-11-00	Cowling, Engines No. 1 and 3 - Maintenance Practices
71-12-00	Cowling, Engine No. 2 - Maintenance Practices
80-11-19	Starter Control Valve Fitter - Removal and Installation
80-11-19	Starter Control Valve Filter - Cleaning and Painting

2. Inspection/Check

A. External Inspection

(1) On Flight Engineer/Second Officers circuit breaker panel CB3, zone 215, open and tag applicable START AIR VALVE circuit breaker.

(2) Tag ENGINE START panel for non-operation.

(3) Open RH hinged cowl 414A or 424A (Eng. No. 1 or 3) or lower RH hinged cowl 434AR (Eng. No. 2) to gain access to the engine starter control valve.

(4) Examine control valve actuator body and starter valve body for cracks, corrosion, or signs of air leakage. Check for loose screws.

(5) Inspect electrical connector for corrosion (Ref. Fig. 401).

B. Internal Inspection

R (1) Remove starter control valve filter (Ref. 80-11-19).

R (2) Inspect air filter for general condition and clean as
R necessary (Ref. 80-11-19).

R (3) Reinstall air filter (Ref. 80-11-19).

C. Check

(1) Apply wrench to lower manual operation hex fitting and rotate butterfly disk shaft clockwise. Observe that

position indicator lever on top of actuator rotates from 'C' to 'O' position as indicated by letters on actuator body.

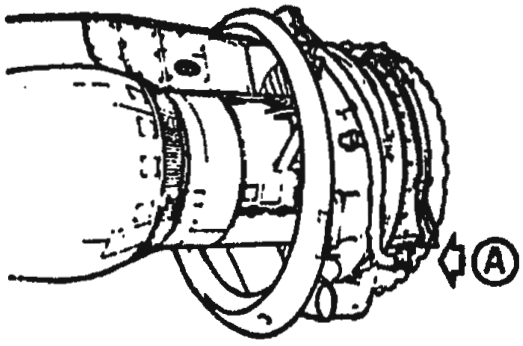
(2) Rotate hex fitting counterclockwise to close valve.

(3) Depress manual override button on solenoid valve to check for free movement. Spring tension must return button to initial position when button is released.

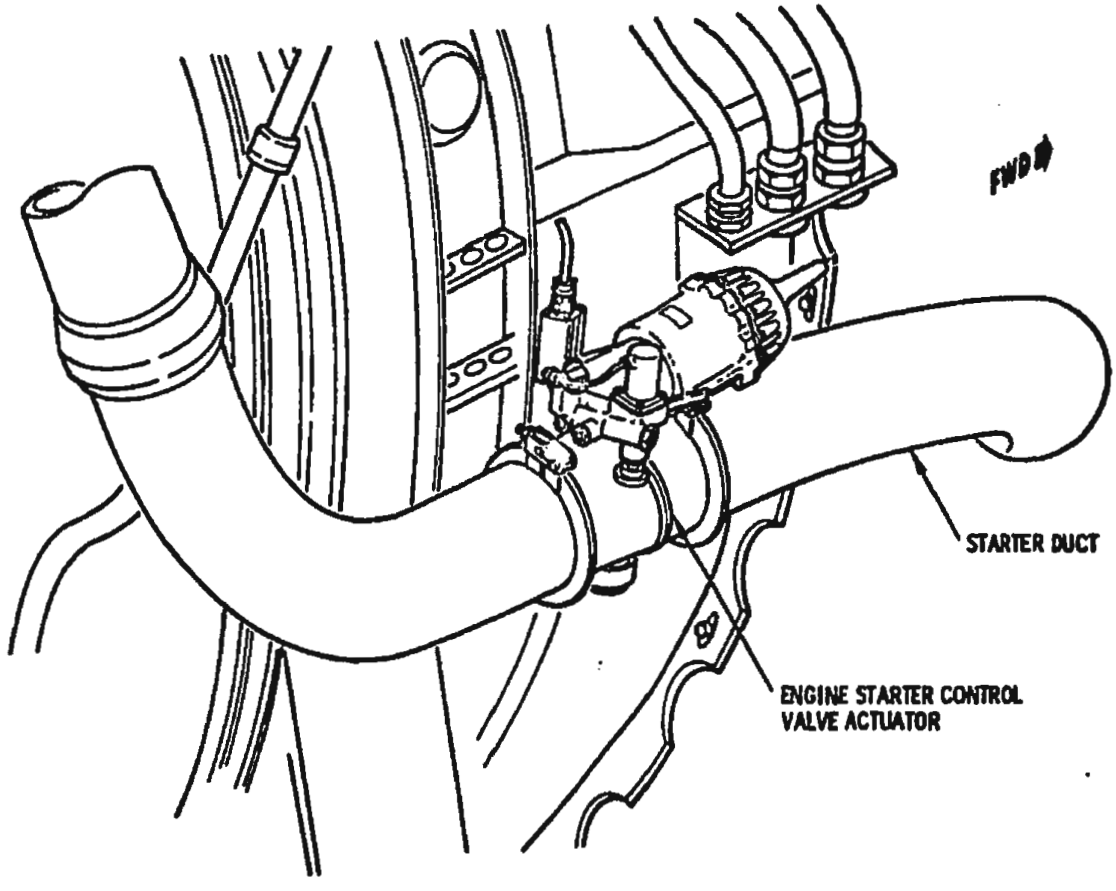
(4) Close cowl 414A, 424A, or 434AR.

(5) Remove tag and close circuit breaker opened in Step 2A(1).

(6) Remove tag installed in Step 2A(2).



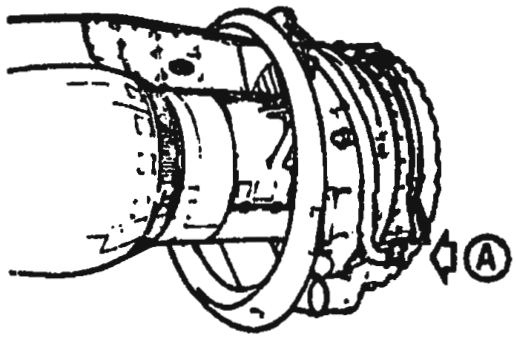
RIGHT SIDE VIEW



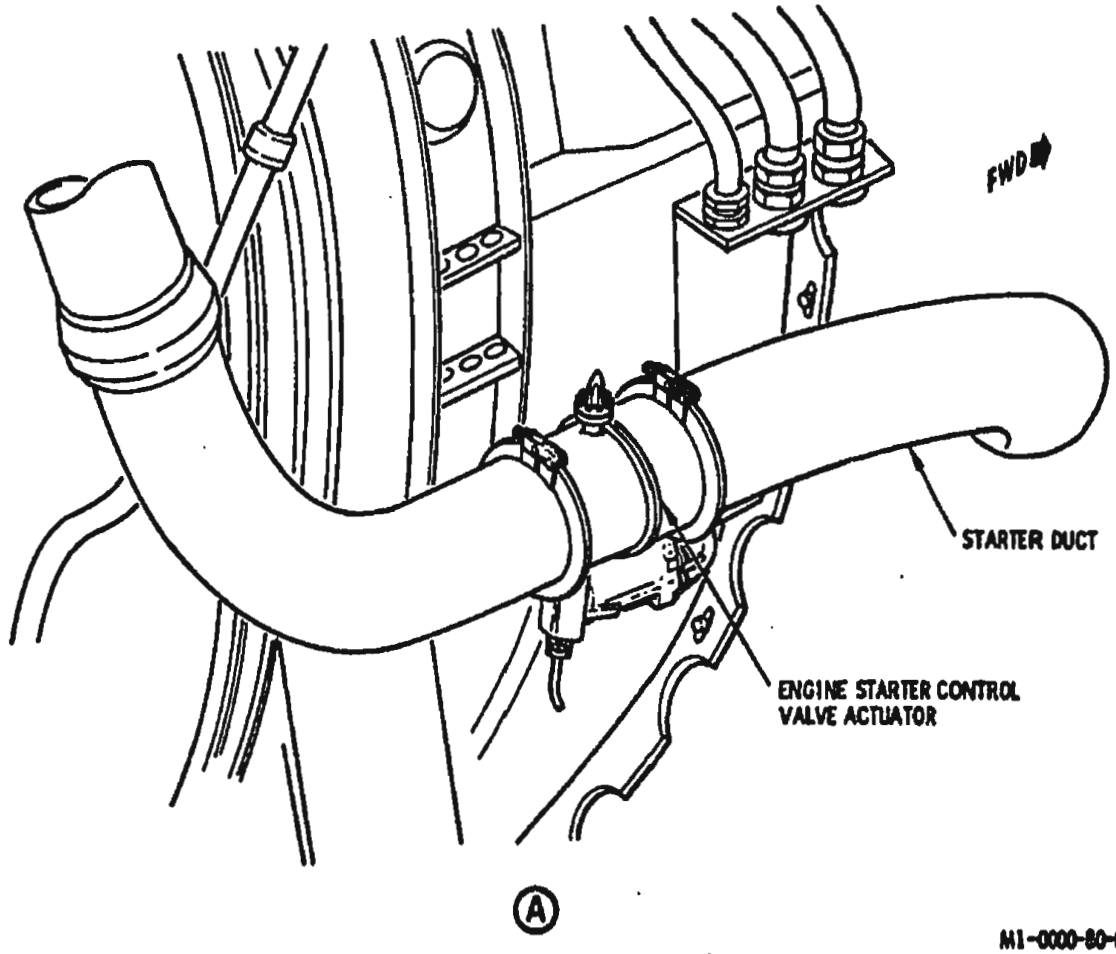
M1-0000-80-076

Engine Starter Control Valve
Inspection and Check
Figure 601

R
R
001B EFFECTIVITY: WITH VALVE ACTUATOR FACING UP

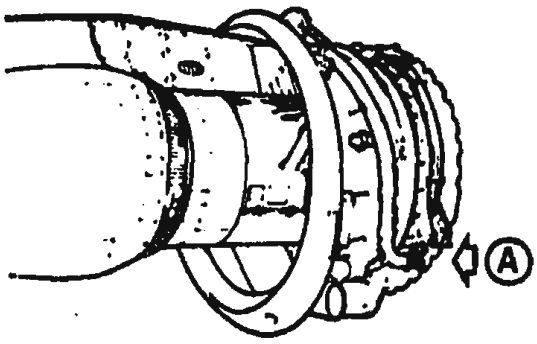


RIGHT SIDE VIEW

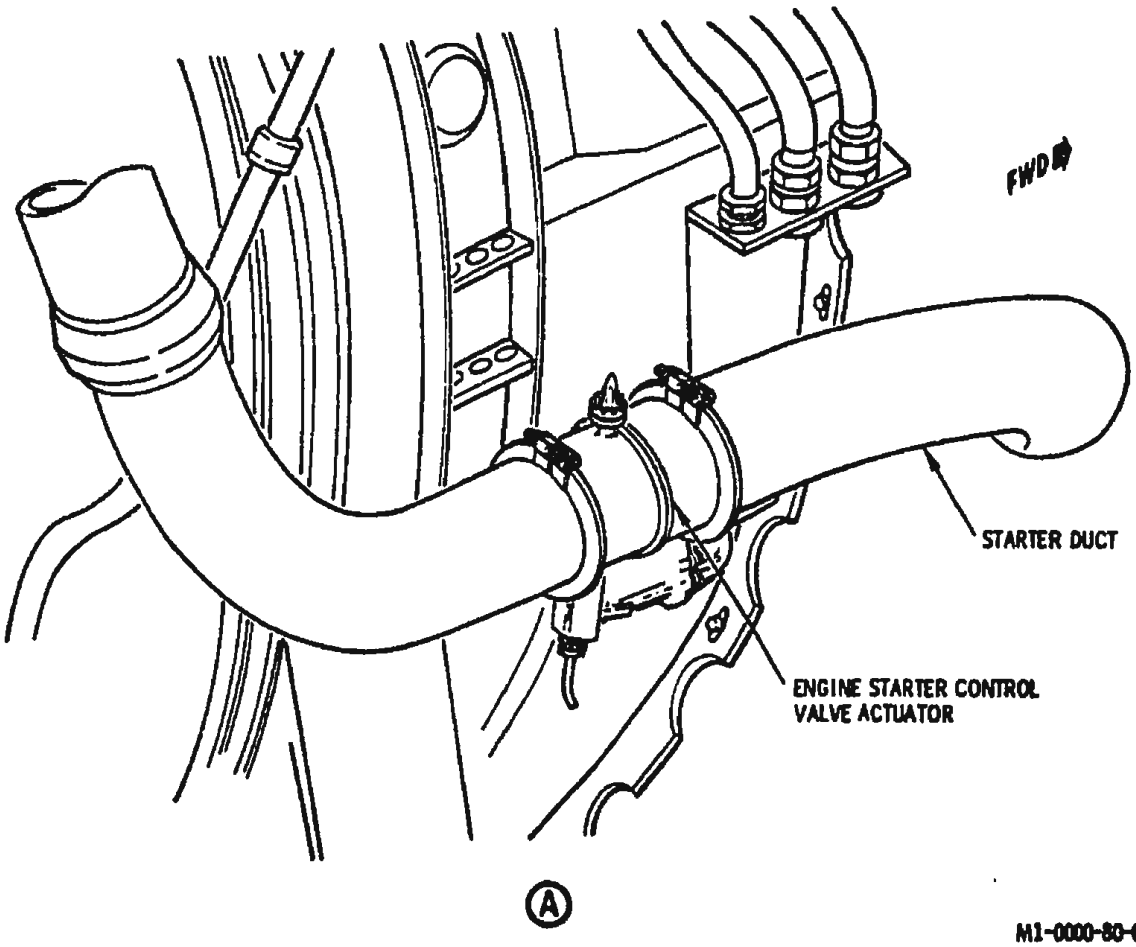


Engine Starter Control Valve
Inspection and Check
Figure 601

R EFFECTIVITY: WITH VALVE ACTUATOR FACING DOWN
R
001B



RIGHT SIDE VIEW



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R Engine Starter Control Valve
R Inspection and Check
R Figure 401

R EFFECTIVITY: 032-999 WITH
R VALVE ACTUATOR FACING DOWN
001B

STARTER HOUSING ADAPTER - REMOVAL AND INSTALLATION

1. Equipment and Materials

   Preformed packing (Ref. Fig. 401)

2. Referenced Procedure

   80-11-07 Engine Pneumatic Starter - Removal and Installation

3. Removal/Installation

   A. Removal

      (1) Remove pneumatic starter (Ref. 80-11-07, Removal and Installation).

      (2) Remove housing adapter from high-speed gearbox mounting pad. Retain attaching hardware (Ref. Fig. 401).

      NOTE: Flange pilot and index pin may prevent easy removal of adapter from pad. Light tapping of adapter circumference with plastic mallet will expedite removal.

      (3) Remove and discard large preformed packing from pilot groove.

   B. Installation

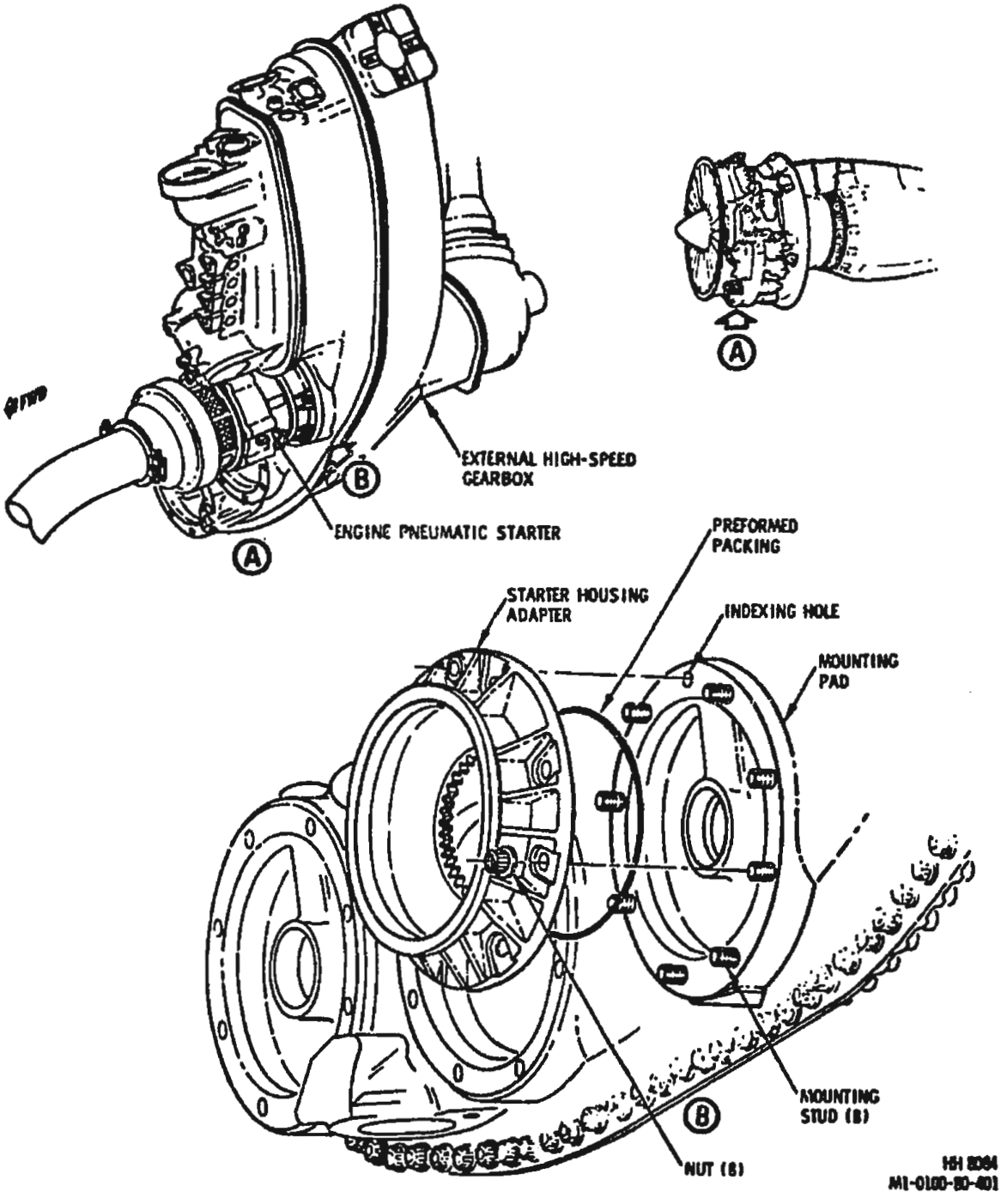
      (1) Install new preformed packing in groove on adapter pilot.

      (2) Align index pin on adapter flange (at 12-o'clock position) with indexing hole in gearbox pad, and slide adapter on mounting studs.

      (3) Engage pilot in mounting pad, and push adapter into place to avoid damaging preformed packing.

      (4) Secure adapter with self-locking nuts.

      (5) Install starter (Ref. 80-11-07, Removal and Installation).



Starter Housing Adapter Installation
Figure 401

OIL FILL QD COUPLING - REMOVAL AND INSTALLATION

1. Equipment and Materials

   Preformed packing (Ref. Fig. 401)

   Lock-wire, PN MS20995NC20, or equivalent

2. Referenced Procedures

   71-11-00 Cowling, Engines No. 1 and 3 - Maintenance Practices

   71-12-00 Cowling, Engine No. 2 - Maintenance Practices

3. Removal/Installation

   A. Removal

      (1) Open cowling (Ref. 71-11-00 or 71-12-00).

      (2) Detach coupling cap connecting cable from oil fill port boss (Ref. Fig. 401).

      (3) Remove oil fill quick-disconnect (QD) coupling from port. Discard preformed packing.

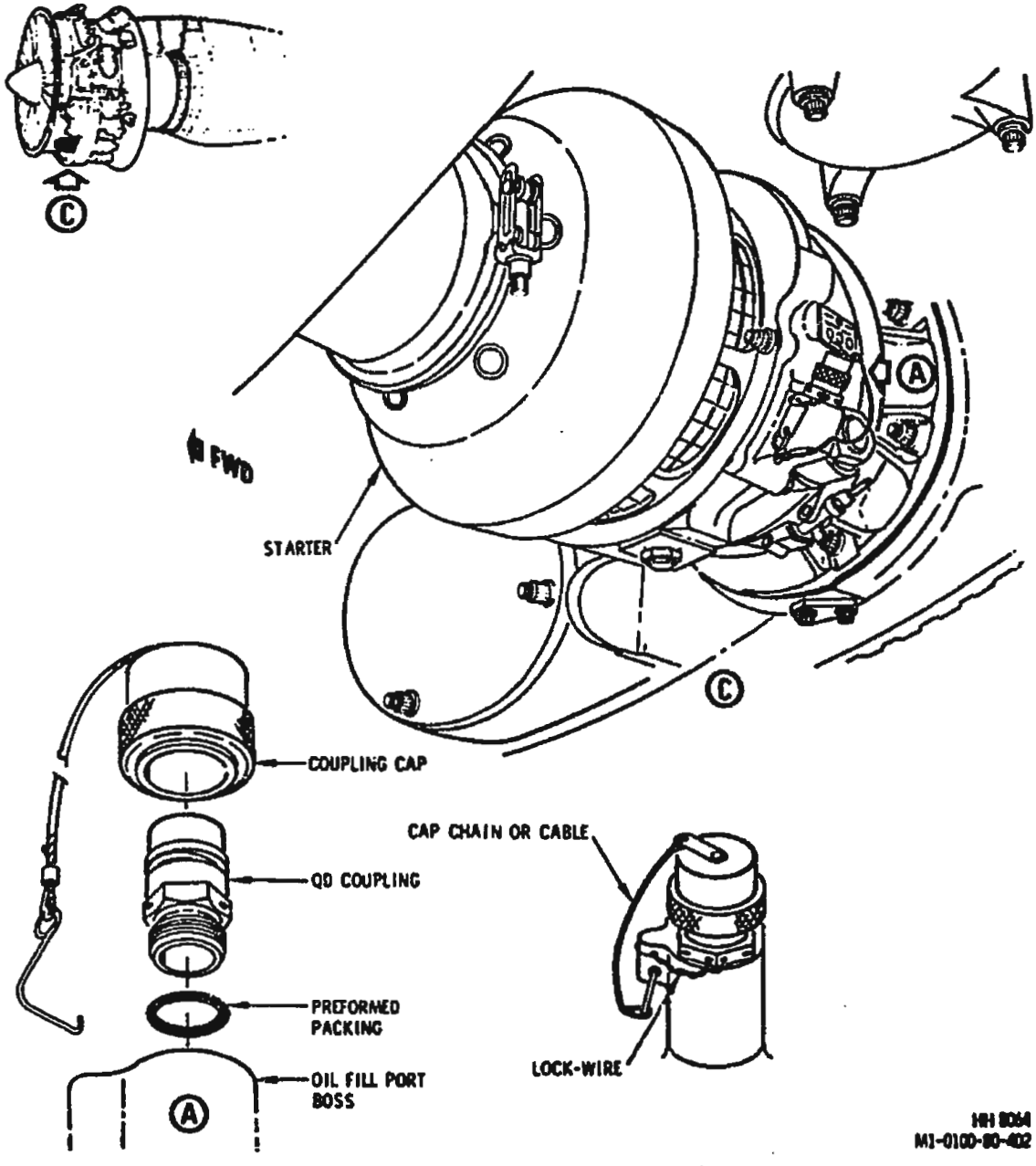
   B. Installation

      (1) Install new preformed packing on QD coupling.

      (2) Install coupling in oil fill port and torque 20 to 35 lb in. Lock-wire as shown in Fig. 401.

      (3) Secure coupling cap cable to oil port boss.

      (4) Close cowling (Ref. 71-11-00 or 71-12-00).



Oil Fill QD Coupling - Removal and Installation
Figure 401

STARTER CONTROL SOLENOID VALVE - REMOVAL AND INSTALLATION

1. Referenced Procedures

R 71-11-00 Cowling, Engines No. 1 and 3 - Servicing

R 71-12-01 LH and RH Lower Hinged Cowl - Servicing

2. Removal/Installation

A. Removal

(1) On Flight Engineer/Second Officers aft circuit breaker panel CB3, zone 215, open and tag applicable START AIR VALVE circuit breaker.

(2) Open applicable RH hinged cowl 414A or 424A for engines No. 1 and 3 (Ref. 71-11-00) or 434AR for engine No. 2 (Ref. 71-12-01) to gain access to starter control valve.

(3) Remove attaching screws and withdraw solenoid valve from aft side of control valve actuator housing (Ref. Fig. 401).

(4) Remove and discard both preformed packings.

B. Installation

(1) Verify that circuit breaker opened in Step 2A(1) is open and tagged.

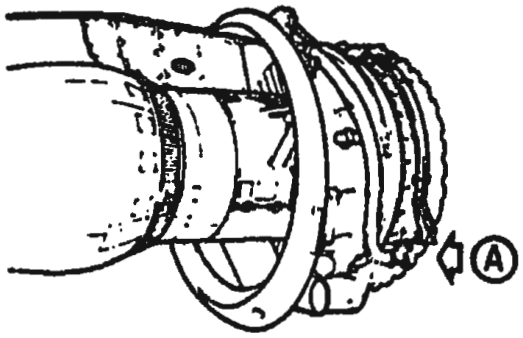
(2) Install new preformed packings on solenoid valve.

(3) Insert valve into actuator body bore, using care not to damage packings on lip of bore, and install attaching screws.

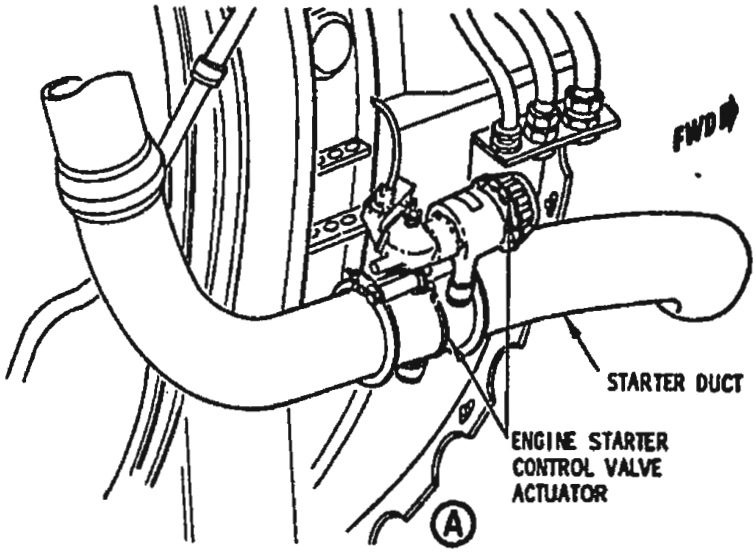
(4) Close cowl opened in Step 2A(2).

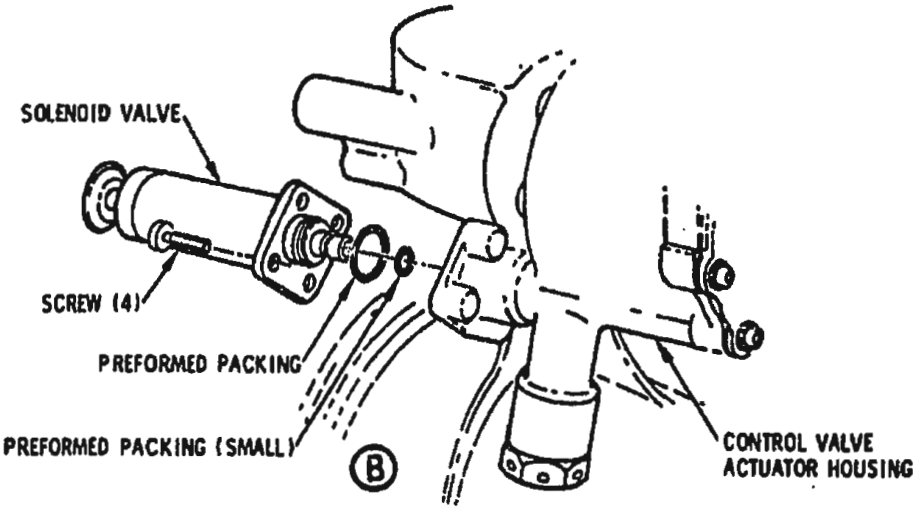
(5) Remove tag and close applicable START AIR VALVE circuit breaker opened in Step 2A(1).

(6) Verify solenoid valve operation on next engine run.



RIGHT SIDE VIEW





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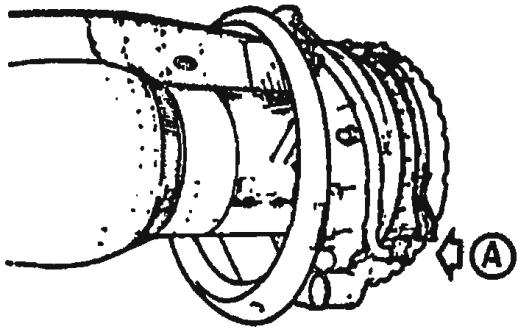
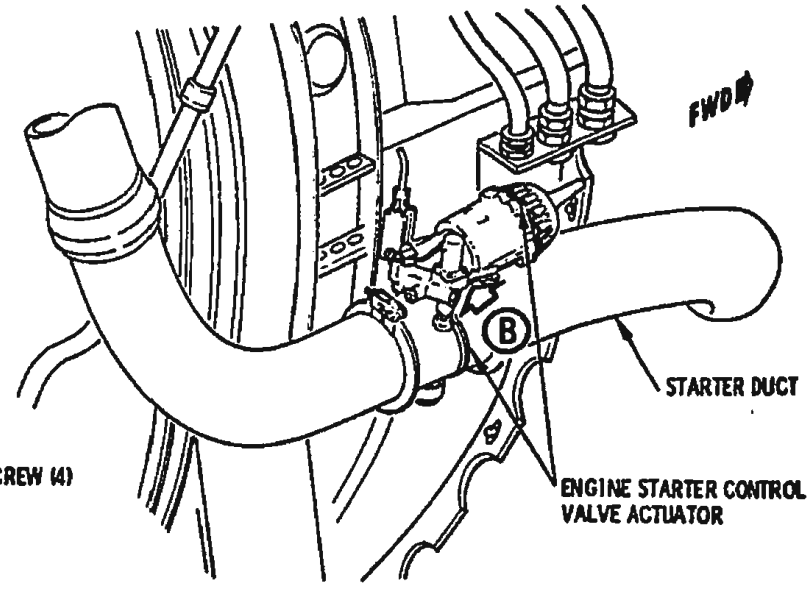
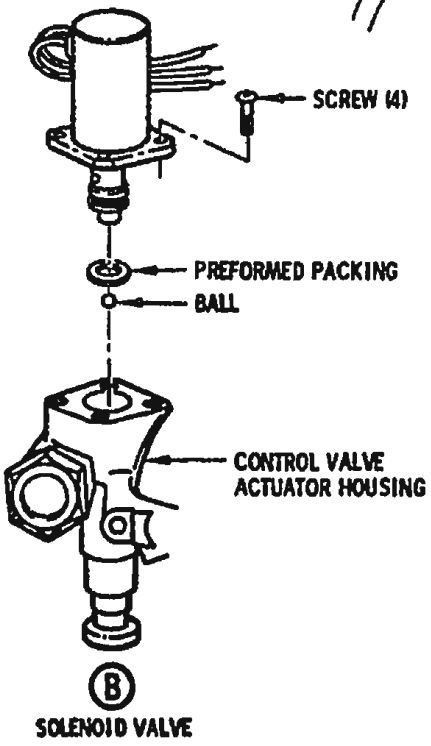
Solenoid Valve - Removal and Installation
Figure 401



RIGHT SIDE VIEW



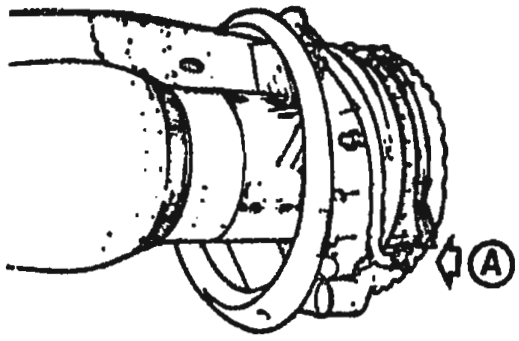


SOLENOID VALVE

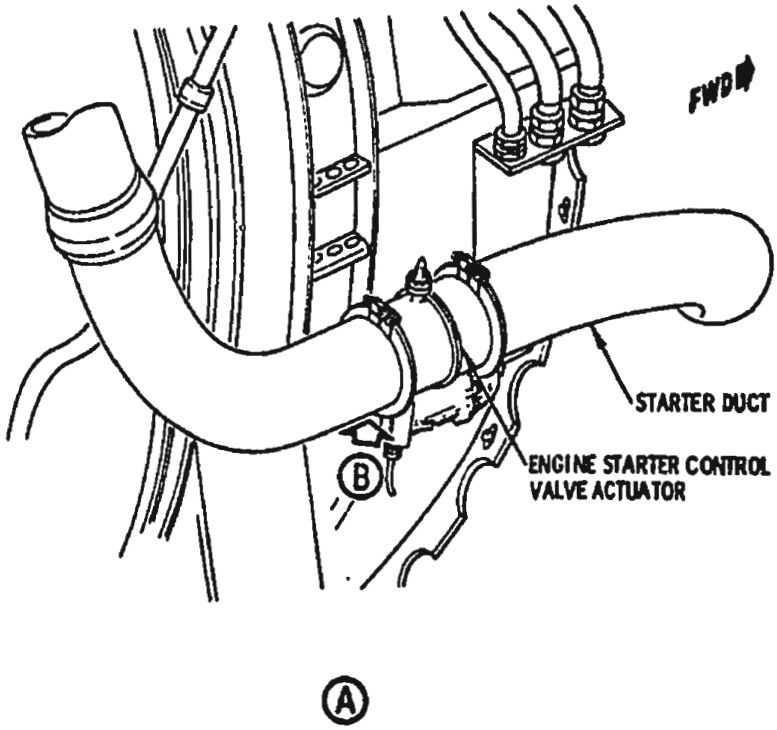
MI-0000-80-077

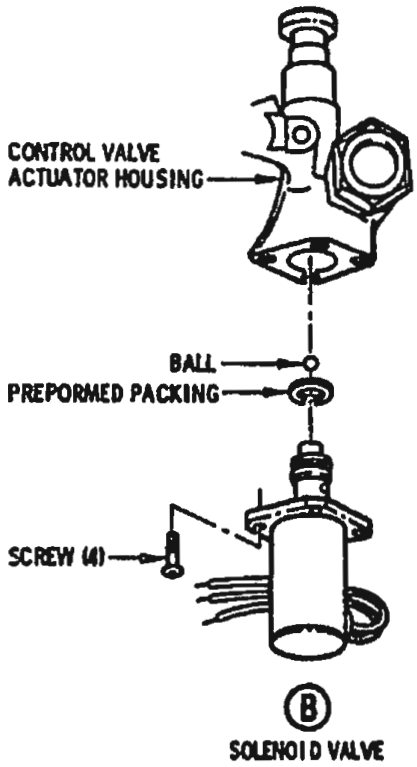
Solenoid Valve - Removal and Installation
Figure 401

R EFFECTIVITY: P/N 671513-111 OR LATER VALVES
R WITH VALVE ACTUATOR FACING UP
001B



RIGHT SIDE VIEW





SOLENOID VALVE

M1-0000-80-078

Solenoid Valve - Removal and Installation
Figure 401

R EFFECTIVITY: P/N 671513-113 OR LATER VALVES
R WITH VALVE ACTUATOR FACING DOWN
001B

STARTER CONTROL VALVE FILTER - REMOVAL AND INSTALLATION

1. Referenced Procedures

R 71-11-00 Cowling, Engines No. 1 and 3 - Servicing

R 71-12-01 LH and RH Lower Hinged Cowl - Servicing

2. Removal/Installation

A. Removal

(1) On Flight Engineer/Second Officers aft circuit breaker panel CB3, zone 215, open and tag applicable START AIR VALVE circuit breaker.

(2) Open applicable RH hinged cowl 414A or 424A for engine No. 1 and 3 (Ref. 71-11-00) or 434AR for engine No. 2 (Ref. 71-12-01) to gain access to starter control valve.

(3) Remove filter plug, spring, and air filter from actuator housing protrusion. Discard preformed packing (Ref. Fig. 401).

B. Installation

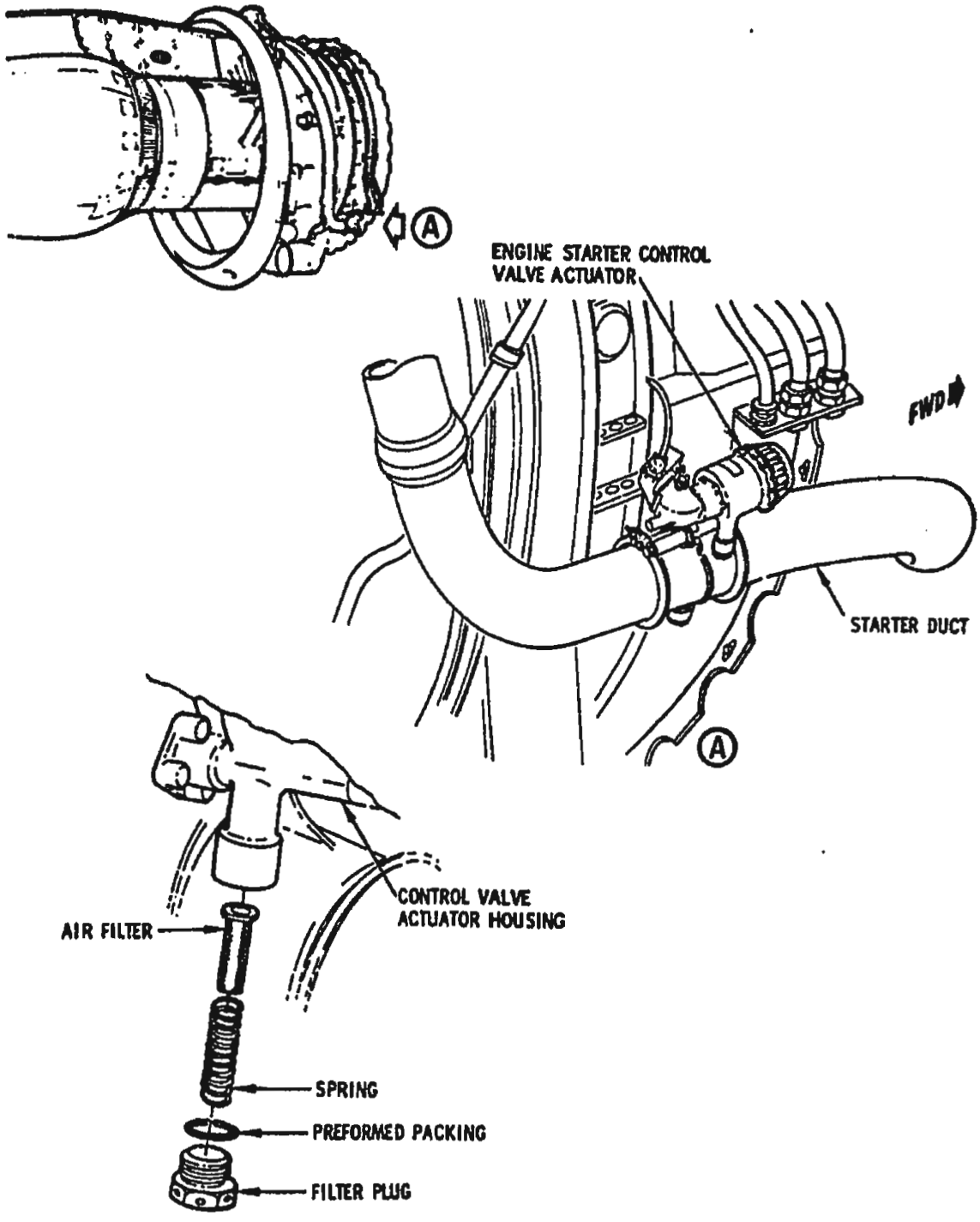
(1) Verify that circuit breaker opened in Step 2A(1) is open and tagged.

(2) Install new preformed packing on filter plug.

(3) Install clean filter, spring, and plug. Tighten plug 60 to 70 lb in. and lock-wire.

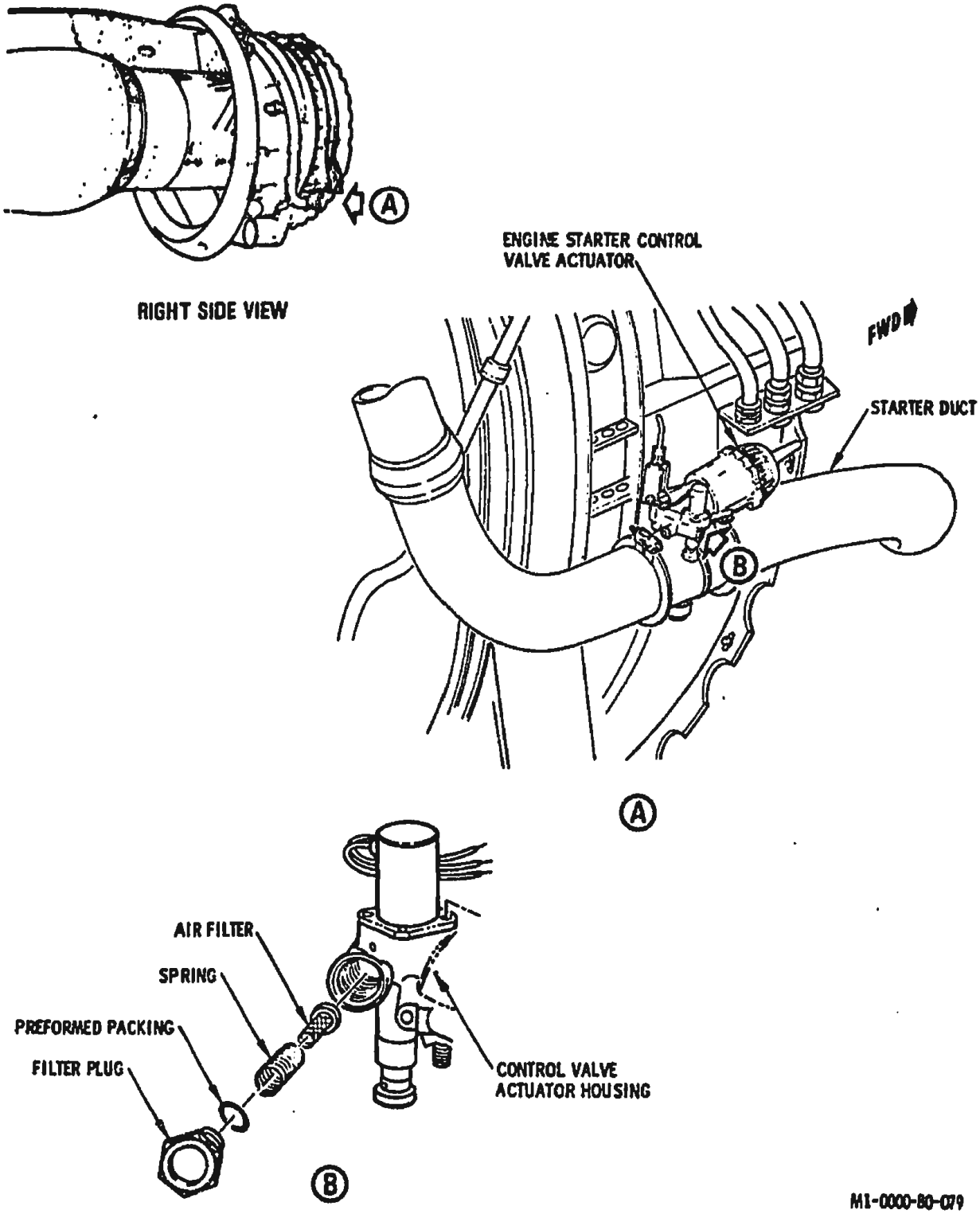
(4) Close cowl opened in Step 2A(2).

(5) Remove tag and close applicable START AIR VALVE circuit breaker opened in Step 2A(1).



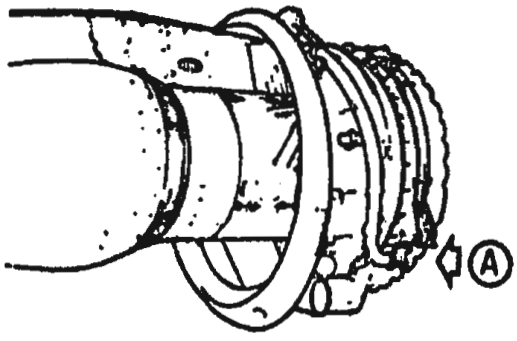
M1-0002-80-404

Starter Control Valve Filter
Removal and Installation
Figure 401

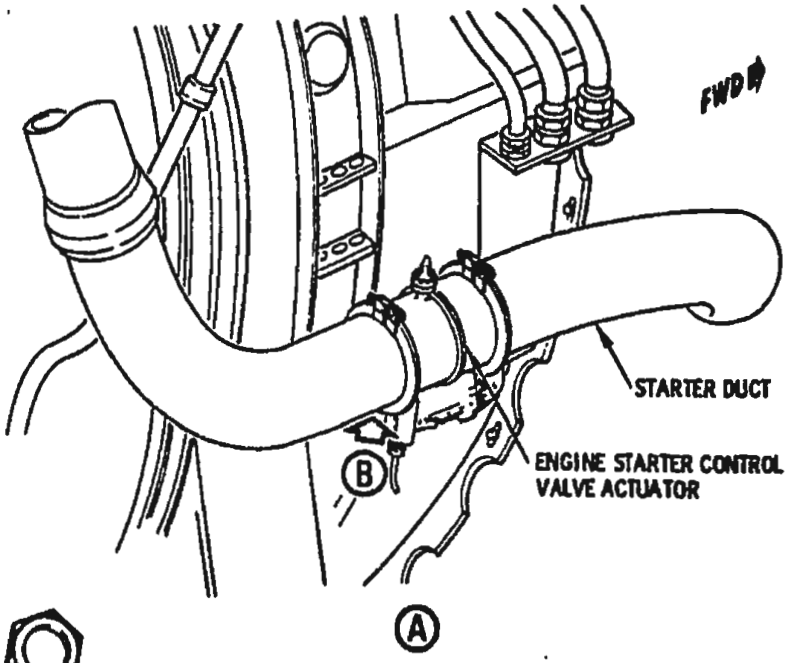


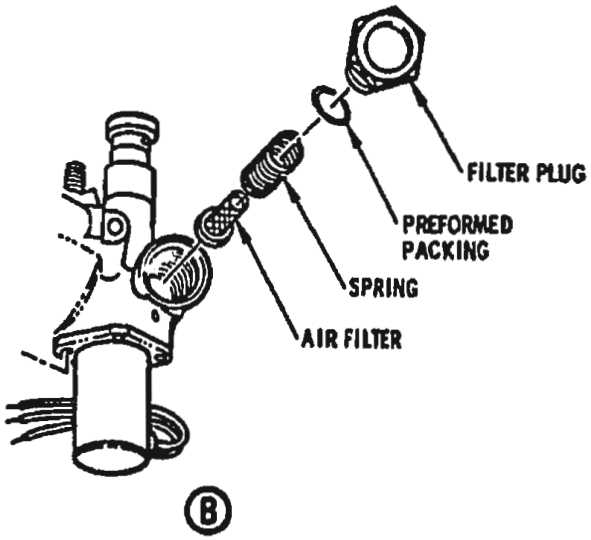
Starter Control Valve Filter
Removal and Installation
Figure 401

R EFFECTIVITY: P/N 671513-111 OR LATER VALVES
R WITH VALVE ACTUATOR FACING UP
001B



RIGHT SIDE VIEW





M1-0000-80-000

Starter Control Valve Filter
Removal and Installation
Figure 401

R EFFECTIVITY: P/N 671513-113 OR LATER VALVES
R WITH VALVE ACTUATOR FACING DOWN
001B

R STARTER CONTROL VALVE FILTER - CLEANING AND PAINTING

R 1. Equipment and Materials

R Stoddard Solvent, Federal Specification P-D-680, or equivalent

R 2. Referenced Procedures

R 80-11-19 Starter Control Valve Filter - Removal and
R Installation

R 3. Cleaning/Painting

R A. Cleaning

R (1) Remove starter control valve filter (Ref. 80-11-19,
R Page 401).

R WARNING: SOLVENT IS TOXIC AND FLAMMABLE. USE ONLY IN
R WELL-VENTILATED AREA, AWAY FROM OPEN FLAME.

R CAUTION: COMPRESSED AIR MUST BE USED WITH CARE TO AVOID
R DAMAGING FINE MESH OF FILTER SCREEN.

R (2) Wash filter thoroughly in solvent. Use dry, filtered,
R compressed air to dry filter.

R (3) Install clean filter (Ref. 80-11-19, Page 401).